Hans Gaffron

Resistance To Knowledge

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"Everything reasonable has been thought of before. We have just to try to think it once anew."

—Goethe.

"The reason why philosophers give us only limited pleasure is that they do not talk enough about things we already know."

—Vauvenargues.

When the editors of the *Annual Review of Plant Physiology* honored me with an invitation to fill a few pages in a manner different from the usual specialized review, I decided that the best I could do was to tell the young scientist about the hopes or worries of an older colleague who has seen the proverbial better times.

At best, five per cent of the population are truly familiar with the cultural problems of our era. They are the five per cent who study, discuss, and write such articles and books as I shall be referring to in the course of these remarks. My aim is to emphasize that these five per cent ("we the intellectuals") are talking mainly to one another. Judging from what happens in the real world, very little of what is called common or even obvious knowledge among this small group seems to affect the behavior and judgment of the ninety-five per cent of the people and their chosen leaders who together constitute the living power of the species.

The following is therefore addressed to the biologists who were not yet born when two world wars had led to an almost universal acknowledgement of the West's cultural decline. While they were growing up, the fabulous success of applied science could be taken as an indication that the sinister trend had halted. Living standards in the Western countries, as well as their capacities for destruction, are higher now than in the golden age before 1914. This so-called triumph of scientific progress has made it quite hard for young enthusiastic people to realize that the decline of the West continues, and that more of the same kind of technical progress offers no solution.

At the time of Erasmus it was considered wise, as well as ethically permissible, for the happy few to hold aloof from the affairs of the world and to contemplate with amused equanimity the rule of folly among men. The world and human nature were as God had made them and had to be taken whole: to try to change either would be part of that folly. Four hundred years later it has become clear that we ourselves are now remaking our world. Therefore it is not permissible to sit back and smile at the horrendous mistakes which are being committed out of sheer ignorance about man's nature and its possibilities. When those who have a couple of thousand dollars may in a few hours fly to any region of the globe, when on this shrunken planet a billion people are constantly disturbed with news that during all previous history was none of their business, when so many are made to witness events they never cared to dream about, a biologist may wonder what this will do to the minds of people who were hitherto encapsulated in their particular cultural background and limited traditional knowledge, and who saw in any difference of opinion with their neighbors enough of an excuse to start understandably rapacious wars or completely irrational ones.

In this age of biology we should be able to do something rational about our cultural affairs. That means we have to begin in earnest with a science of human nature. Ordinarily, when asked today what he would consider a worthwhile problem, a younger biologist is likely to mention the origin of life, the problems of aging, the molecular basis of consciousness, the genetic remodeling of future generations, and so on. Such problems are not only great, they also have the advantage of being perfectly safe. They are far removed from the here and now; they invite detachment from the immediate state of human affairs. But an enquiry as to whether the mental development of modern man, or the lack of it, justifies his acquiescence with social institutions as they presently exist—that is risky. No scientist is to be blamed when he subsconsciously avoids immersing himself seriously in such matters. Continually since the times of Bruno and Galileo there have been disagreeable

encounters between independent philosophers, natural and otherwise, and the men of God who, since ancient times, insist that the minds of the people have been given into their hands to care for. Trespassers, therefore, will be prosecuted. Hence even modern scientists generally prefer to stick to investigations which are not likely to be called controversial.

The ultimate aim of the combined studies of human nature is, of course, a moral and political one; and for this reason such studies will be discouraged. Those whose power depends on millions of unthinking followers realize that this kind of biology and the teaching of it is subversive. Why otherwise should a society which is so eager to exploit immediately any discovery in physics or medical biochemistry demur at making practical use of what sociologists or psychologists have discovered about the behavior and the motives of its members? But as fortunate citizens of this country, we know that in the Anglo-Saxon nations so far people have not been abducted in the early hours of the morning for having made statements deemed ideologically dangerous to those in power. The worst that can happen to a biologist who wants to investigate the causes of narrow-mindedness and stubbornly preserved ignorance in the minds of public leaders is that they probably will not pay him to do so. Such tolerance will last until his work shows a kind of success which so persuasively calls for far-reaching social reforms as to rally not only the support of intellectuals but that also of the man in the street. Many, considering the way they have been trained, and particularly when they are already "on the way up," may not find this a problem they ought to bother with. Having joined what has become a lucrative profession and which in addition offers the traditional lure of unhindered intellectual adventure, they see no reason why they as contented specialists should trouble themselves to read and ponder a few of the books and articles on the cultural dilemma of our times which their older colleagues have felt moved to put before them. Is one not already hard pressed for time to cover the literature in one's own field? To this we must answer that pure self-interest—namely the desire

to end one's life in a society not so tormented as ours by the baffling conflict between surviving superstitions and new biological insights—should dictate a young scientist's choice of work in a field where the problems reach from the chemistry of emotions to the ancient question of whether intellectuals are forever condemned to remain so powerless in public affairs.

I am, of course, aware of the incessant flow of dedicated expert articles and books which appear or are reviewed in the *Saturday Review*, the *Bulletin of the Atomic Scientists*, *Foreign Affairs*, *Science*, even *Time* and *Life*, etc. In addition, we have the Pugwash conferences and other valiant efforts of the intellectual world in behalf of common sense when it is supported by indisputable facts available to anyone who wants to inform himself. Yet the ever-recurring waves of violence or authoritarian pronouncements of world leaders drown out the voices of reason. Quite obviously, the gap between the world of the intellectuals, defined as those who think because they cannot do otherwise, and those who wield the power while they also claim that they cannot do otherwise, has been bridged. Thus the biologist who wishes to find out why he and his like are so ineffective in the affairs of men must turn to the slow method of scientific analysis.

PRE-1914 PREJUDICES AND INDOCTRINATION

In contrast to what a scientist is usually trying to establish by his writings, this article does not offer new insight nor results based on objective original research, only views on how socially important prejudices, including mine, have changed during the last half-century under the influence of what is usually called the scientific viewpoint. Though this viewpoint is shared at the present time only by a few, there is no reason why it could not be the start of a new kind of ethical indoctrination which, when properly imparted to the young, would hold as securely as those for which in former times the appeal to the authority of supernatural powers appeared indispensable.

The spiritual world I grew up in lasted practically unchanged till the middle 1920's. Part of my early indoctrination before 1914 was essentially based on a pious faith in progress. I learned that in principle Christian Europeans had given up war long before I was born. The modern ways to exploit inexhaustible natural resources made obsolete such barbaric methods to enrich the various fatherlands. Now everybody could be a winner without someone else having to lose. By the same token, lower class people would soon prosper to the point there would be no need to pity them. In addition, they were promised to be taken care of in heaven. Armies were needed only to maintain national honor; as an example of what that meant, I was told how it had been necessary that all honorable European countries send soldiers to China to shoot the nasty Boxers. And honor was again on everybody's lips in 1914.

The first political map I saw had three main colors: pink for British rule, violet for French, and green for Russian. Pink was everywhere—over a good part of the world. Under the pink and violet colors lived many hopelessly savage tribes, as in Africa, for instance. The wise Christian Europeans prevented them from torturing each other to death in the most gruesome ways. Nevertheless, it was to be hoped that these savages would somehow fade away and become less of the white man's burden. Conspicuous on

the map were also *China and the United* States, both in yellow; white unexplored patches were at the poles, inside Asia, and in Africa. They beckoned courageous explorers to become living or dead heroes who somehow let all their compatriots, who did nothing, feel more important. The Germans had come too late to receive their "just" share of the colonial world, but to compensate for this they were ahead in the spiritual world because of their philosophers, poets, composers, and scientists. China was the most foreign of all countries. Her art objects had to be collected by anybody who was somebody. On the other hand, the incredible numbers of the Chinese were a vague but distinctly unpleasant threat. Yet a rapid increase in the populations of Europe was a sign of well-being. To to be slow in producing children was a sign of decadence. America was an enormous, mainly unexplored country where enterprising people went either because they wanted to make a million or had already stolen one.

This was the kind of outer world I was made to believe in when I was brought from Peru to Europe and Germany at the age of ten. I assume it was, except for patriotic variations, the same indoctrination that all bourgeois children received throughout Europe, and Alan Paton has recently mentioned that the same attitude prevailed in remote South Africa. Actually, the political world was only dimly seen. It was unnecessary to worry about it, for it was in the hands of leaders appointed by the grace of God.

My standard of justice was set for good by what I had heard and later avidly read about the Dreyfus case. In a civilized country, official injustice suffered by one man was enough to rally all men of good will and integrity to set things right. Compromises were impossible—either you were civilized or you were not. Today justice is measured by degrees. It makes a difference whether only a few or thousands of innocent people at once are mistreated or murdered because of "reasons of state." Sometimes a modern Zola writes disagreeable articles and then the case is officially deeply regretted. The true cultural decline of the West is sensed only by those who remember Dreyfus.

After the military had been defeated in 1919, the Weimar Republic came into being. Arts and sciences re-emerged and unfolded quickly to a prewar level. In the Twenties all Europe enjoyed an incredible upsurge, seemingly a complete cultural recovery. Research, literature, painting, music, and theater flourished just in time for me, between the ages of seventeen and twenty-seven, to believe that this was a great era in which to be alive. Inflation, poverty, and political murders followed by lopsided application of justice, I considered the distasteful but understandable aftermath of the war. The war had clearly been a terrible mistake, and we were sure that such idiotic, useless killings among civilized peoples would not occur again. The one truly new apparition on the cultural horizon was the Soviet Union: horror stories on the one hand, and great hopes on the other, for this was the first attempt at running a country in a rational and just manner on behalf of all the people.

The long misery of the first World War had helped me to get rid of the illusions of false patriotism and church religion in a logical, interesting, and rather enjoyable way. (To the subconscious influence on a child's mind of Catholicism in the Latin American style, I shall return later.) But the political trials under Stalin, the breakdown of the German republic, and the swift disappearance also in Italy of all but the trappings of civilization destroyed the last of my cherished illusions – the belief that the Europeans would instinctively repudiate criminals as their leaders.

Today the pink and the violet have disappeared from the political maps of the world, leaving a very impressive blotch of Russian green, with only the United States and China as large as before. No white unexplored spaces are left. Between 1914 and now, about one hundred million people (fifty million officially counted) were prematurely deprived of their lives thanks alone to the irrational brutality of their fellow men. Part of the horror is that nobody misses them any more. But the ideal of a stable, advancing, trustworthy Western civilization did vanish. Can it be revived? In the eighth year of our private American missionary

war, young people have a hard time believing that this ideal was ever more than the Utopia of a few. I like to stress the point, therefore, that before 1914 this ideal was alive in nearly everybody's mind regardless of his immediate political aims or church affiliations.

Every society is faced with the problem of how to civilize its children to make them conform to customs and, if possible, to follow an ideal set on a somewhat higher level than that considered practical for the moment. Every year in the United States, a fresh 3.6 million little barbarians arrive, not to mention the million and a half every month in India and unknown millions in China. The comfort, if not the safety, of the parents requires from the first day the application of a technique to obtain obedience, preferably one which culminates in submission to rules by the subconscious consent of the ruled. The diversity of such techniques of necessary indoctrinations, as well as differences in ideals proclaimed as the ultimate good, have been one of the main causes for strife and fanatical bloodshed throughout the course of human history. In our age of scientific historical surveys, the time has arrived for some comparative analysis of the various indoctrination systems now being practised to determine which of them promise most for coming generations' mental development. This has been with me ever since my exposure to three successive levels of religious and ethical instruction. During my preschool years, I spent more time in the company of servants than of my parents. Thus I learned to share their beliefs, which one would not hesitate to call dark and cruel superstitions of a bygone age were it not that they form a part of the Catholic faith as it is still being practised among the Indians and the very poor of Latin America. Looking backward, the essence seems to have been a constant fear of punishment for the sin of being a little more alive than required for mere survival. The affirmation that God is Love and that after some years of burning in purgatory all will be well in the next world, made much less impression on me than the detailed stories of how the devil was going to torture us unless we had a particular patron saint (or better

still, several of them) who would argue for mitigating circumstances. The power of the saints was evident from the way they lived in the splendors of their churches. The high vaults resounding with the voices of murmuring and chanting monks, the gold glittering in the light of many candles were an unforgettable fascinating reality. These impressive rituals somehow imparted credence to an unreal world whose existence had to be believed.

In addition, the tales and the superstitions of the lower class populated my mind with ghosts of an unfriendly disposition, and though they seemed not to play an official role in church affairs, they had the frightful advantage of existing right here with us in our daily lives on earth. Because of the regular return to the upper world of my parents, where everything was serene, understandable, non-mystical and definitely free of ghosts, none of this did any lasting harm, I assume, but it instilled in me a great emotional attraction for any kind of beautiful ritual. Then came years of Protestant instruction with the emphasis on one's own ability to distinguish between right and wrong according to one's conscience. There was less emphasis on absolute obedience to an authoritarian church, but insistence on salvation through unwavering faith. I do not remember any particular criticisms of church religion by my father, who was a zoologist and physician. Simply by his knowledgeable answers to any questions I might raise, he easily remade me into a believer in evolution long before I was truly able to understand the validity of the arguments in favor of Darwinism. In the meantime, I had discovered those philosophers whose writings do not appear in the usual high school curricula. To my relief, I learned that in past centuries there had been quite a few thinkers who had agreed that an earnest contemplation of the wonders of this world compensated fully for loss of belief in the hereafter or in the existence of a capricious supernatural power outside nature.

When I began my university studies, I took with me two books that had just appeared—Karl Jaspers' *Psychologie der Weltanschauungen*[1] and Spengler's *Decline of the West*. I was fascinated by both,

though I never finished perusing either of them because of their verbosity. I hated and cursed the Spengler; it promised us a terrible future. But I liked Jaspers' idea of establishing a science which might tell us exactly why we as individuals behave, and behave so differently, as we do. I never separated myself from these books; they have remained emotional poles of departure for daydreams of what to fear and what to hope for mankind. Probably I would have forgotten them were it not that—all his bombastic, apodictic, and often ridiculously nonsensical statements notwithstanding—Spengler's grim predictions have become true. As anyone can see, the time of the tyrants is a long way from being over, and even a great republic continues with military missions to save Asian countries from communism, which, as our authorities do not tire of asserting, is for the natives a fate worse than the most thorough destruction of their country. My only antidote to despair is Jaspers' idea of a natural science of the mind. Fifty years later nearly everywhere in our universities the intuitive approaches in this field—such as Freud's, for instance—are being patiently transformed into respectable biology. Thus my hope is that if the coming generation of biologists will be permitted to survive and to go ahead with their subversive studies, we shall find the means to break the curse of Spengler's and Toynbee's prophecies. Some biologists offer what is, to me, a meaningless sort of consolation. They point out that because of the customary bungling and inefficiency in the application also of destructive means, the species may survive somewhere even when our civilization ends. But who is really interested in the survival of the species, in contrast to that of his family, his own culture, and the few people who represent the latter most brilliantly? My title was chosen to emphasize that a scientifically planned change of human nature must appear subversive in the eyes of those who thrive on the ignorance and habitual thoughtlessness of the majority. Like every great problem in science, this situation has no overall sweeping *a priori* solution. The solution is not in sight—only some most astonishing and promising possibilities.

PERSONAL ASPECTS OF SCIENCE BEFORE 1940

The year 1940 stands as the date when what took at least two decades to emerge finally become obvious: the decline of the West, the ascendancy of technology as the main instrument of power, and the enslavement of Western man by his own machines. Those born after 1940 must encounter no less difficulty in imagining the essentially simple and venerable aspect science possessed during the four centuries before their time than in imagining now the beauty of their home towns in the years before the big trees were cut down to make room for parking lots and four-lane traffic. The young who must live with the new ugliness may therefore be inclined to the opposite view, and say that science was four centuries growing up until it suddenly matured and broke out into full bloom.

In order to get speedily away for good from the unprofitable discussion of pure versus applied science, let me repeat Heisenberg's formulation: "Science clears the fields on which technology can build." In turn, technology delivers to science bigger and better bulldozers to clear the fields ever faster.

Some thirty or more years ago the philosopher Cassirer began a discussion of science with these words:

> Science is the last step in man's mental development and it may be regarded as the highest and most characteristic attainment of human culture. It is a very late and refined product that could not develop except under special conditions. Even the conception of science in its specific sense did not exist before the times of the great Greek thinkers, it had to be re-discovered and re-established in the age of the Renaissance. There is no second power in our modern world which may be compared to that of scientific thought.[2]

What used to—and in many cases still does—attract people into science one can hardly express better than Russell:

> Disinterested curiosity, which is the source of almost all intellectual efforts, finds with astonished delight that science can unveil secrets which might well have seemed forever undiscoverable. The desire for a larger life and

> wider interests, for an escape from private circumstances and even from the whole recurring human cycle of birth and death, is fulfilled by the impersonal cosmic outlook of science as by nothing else. A life devoted to science is therefore a happy life, and its happiness is derived from the very best sources that are open to dwellers on this troubled and passionate planet.[3]

The next paragraph, from an article by Gerald Holton, further illuminates the picture we must see clearly in order to appreciate the difference I shall come to in a moment.

> Science, of course, is not an occupation, such as working in a store, or on an assembly line, that one may pursue or abandon at will. For a creative scientist it is not a matter of free choice what he shall do, indeed it is erroneous to think of him as advancing toward knowledge, it is rather knowledge which advances toward him, grasps him and overwhelms him. Even the most superficial glance at the life and work of a Kepler, a Dalton or a Pasteur would clarify these points.[4]

All this may appear almost self-evident to the young scientist himself. But to the public, which is informed daily about the results of science, such thoughts are entirely alien.

And, as we know from the social history of science, those establishments whose power rests with the God-given ignorance and thoughtlessness of their subjects rightly recognize free science as an ever-present threat. The innocent game of making discoveries has led in the past to a new philosophy about the structure of the world and, lately, about the nature of man. It is an assiduously cultivated myth that in the twentieth century things have changed, that state and church have become totally reconciled to limitless enquiry and are now the supporters of free men. The refined modern way of minimizing the subversive power of research is to divert the minds of scientists from certain problems by offering them unheard-of opportunities to run after those others likely to distract them from thinking methodically about the plight of man as a spiritual being. In addition, the trite arguments about the inability of the scientific method to deal with transcendental ques-

tions are being recast in the jargon of our time and made to sound erudite, scientific and liberal. The meaning of those arguments, however, remains always the same. The only valid spiritual guidelines mankind has ever received to fulfill its destiny according to revealed truth are likely to be undermined by claims that social values have evolved like any other manifestations of human intelligence and might as well be studied objectively. An effective line to counter any such claims goes like this: thoughtful scientists are always willing to admit, are they not, that science is unable to provide or support spiritual values by means of its own philosophy because the latter rests on the collection of facts which are morally neutral?* Opposition to a science of the mind arises only indirectly from the ignorance of the ninety-five per cent, who are so important in a democracy. Their ignorance is carefully abetted and preserved by those men in leading positions who consider it a cardinal virtue to share with the masses some century-old prejudices. Such distinguished personages often possess an admirably high level of knowledge, education and artfulness; they suffer from the single disadvantage of never having been involved in a scientific enquiry; they keep repeating that science is incapable of setting values. I quote from Holton's article, just referred to:

> There are other evidences of the widespread notion that science itself cannot contribute positively to culture. Toynbee, for example, gives a list of "creative individuals" from Xenophon to Hindenburg, from Dante to Lenin, but does not include a single scientist...one may even exhibit a touch of pride in professing ignorance of the structure of the universe or one's own body, of the behavior of matter or of one's own mind.

It is easy to predict that in the near future the science of human behavior will have to wage a struggle, not only for the freedom of research, which is considered less of a threat, but for free teaching, and, most important, for unhampered application of results. The biologist ought therefore to know where he stands and to be sure

*For a more detailed discussion see, for instance, Holton's "Modern Science and the Intellectual Tradition."

of his answers. Accumulation of facts and their superficial classification are, of course, not science. Raw data tell us as much about the edifice of science as a heap of bricks would tell us about a house under construction.

> As a rule the framing of hypotheses is the most difficult part of scientific work, and the part where great ability is indispensable. So far, no method has been found which would make it possible to invent hypotheses by rule. Usually some hypothesis is a necessary preliminary to the collection of facts, since the selection of facts demands some way of determining relevance. Without something of this kind the mere multiplicity of facts is baffling.

If we quote, for instance, the foregoing lines from Russell's *History of Western Philosophy* to our learned opponents, they will immediately say that they knew this all along. Well, if so, why do they repeat or permit others to repeat that the rightful purpose of science is merely the collection of useful facts? And that anything else leads only to demoralization of the people in general...? The reason has been clearly stated by the Catholic philosopher Maritain: science as a force in society works "for the denial of (revealed) truths and eternal values."[5] And to this accusation science must indeed plead guilty. In view of what has happened to Western civilization, we biologists would like to learn how to mold the minds of men so that any values, old or new, become more effective as a vaccine against bestiality.

Considering the power of business and politics, this is, of course, a big program. Our fully accepted standards of advertising, particularly on television, and the eye-opening United Nations sessions during the Near East crisis are impressive examples of the prevailing cult of nontruth. We biologists (or any scientist, if he cares) should strive to make it plain that certain of the oldest and most acclaimed ethical rules (of which smart people secretly believe that nobody keeps them truly) are indispensable in the pursuit of science and are obeyed routinely as a matter of course. Scientific progress is impossible without seeking the truth where-

ever the way may lead. The scientist must be willing to retrace his steps, eat his words, admit errors and defeat, change his mind under pressure of the better argument, even acknowledge the superiority of a rival scientist. To live up to these tenets is not always easy, and our saintliness is not untainted.

Errors and mental blocks occur with scientists as naturally as with anybody else. They are bound to come up like suckers from the understock of personal beliefs on which all science is rooted. Constant pruning is part of the art of transforming individual intuitions into generally acceptable statements.[6]

The great scientist has learned to check his work so thoroughly that no errors may ever show up. A good example of the contrary is the following. I had formed the opinion that the photochemical anaerobic oxidation of sulfide to sulfur in purple bacteria had to be reversible and that the bacteria would release hydrogen sulfide in the dark. I found they did, and after some polemics the matter was settled as true some years later. But at the same time, I also wanted to see whether the sequel, the photochemical oxidation of sulfide to sulfate, reverses in the dark, even though van Niel had maintained that this never happened in his cultures. I proved to my satisfaction that the reaction does occur. Each time I tipped sulfate into a suspension of resting purple bacteria, they began to evolve sulfide as expected, while nothing happened without sulfate. The truth, as van Niel later showed, was that nearly any other salt can also bring the bacteria into action. Under the circumstances, having just proved that the first step from sulfide to sulfur was indeed reversible, an unspecific response to sulfate was for me so unexpected that I failed to do the simple control. I recently found this kind of situation well described in Vauvenargues: "Those who cannot manage to look from many viewpoints sometimes attribute to one entire object what actually belongs only to the little they are aware of. The neatness of their ideas hinders them from being suspicious." I could give one or two more examples of my lack of due caution. But it may come about that a very great scientist, to the distress of his best informed admirers, becomes so infatuated

with his own preconceived idea that he uses all his prestige and experimental skill to uphold an error even when there is overwhelming evidence to the contrary. If his prestige is so high that it has led to a "cult of the individual" within the scientific community, the damage to the work of lesser investigators in the same field may amount to a considerable retardation of scientific progress.

Another failing, particularly unfitting in a scientist, is to accept the master's view as dogma and develop a complete block against any other hypotheses. Again I take myself as an example. I had had the incredible good luck to come into Otto Warburg's laboratory at the age of twenty-three. I promptly fell under the spell of the famous man who a couple of years later supported my first quasi-independent research efforts in the most generous manner. So my loyalty was absolute. Consequently when I first met van Niel in 1931, and when he explained to me photosynthesis on the basis of the theory of Wieland as an oxido-reduction with water, it did not penetrate. I understood the message, but it went against the words of the master, and in my heart I did not believe it. Consequently, as late as 1936 Wohl and I were thinking about a hypothetical way to reduce a carbon dioxide compound directly *à la* Willstätter-Warburg. Only when Hill's chloroplast reaction and later my photoreduction experiments made any other than van Niel's view untenable was I ready to give in.

Upon such a complete surrender of one's critical faculty in a circumscribed area, while remaining otherwise fairly reasonable, rests the initial success of authoritarian governments. In our time it is the most sinister weakness in a human mind, and it behoves us biologists to find out what can be done about it. It happened to me when there was not the slightest ulterior motive to "arrange my thoughts" according to the views of somebody else.

With the change in the conditions of a scientific career since 1940, other troubles and temptations have arisen for the scientist. Polanyi writes about that as follows:

> ...The scientist seeking guidance from scientific opinion must not be tempted to canvass primarily his fellow

> scientists' approval. Though his income, his independence, his influence, in fact his whole standing in the world will depend throughout his career on the amount of credit he can gain in the eyes of scientific opinion, he must not aim primarily at this credit, but only at satisfying the standards of science. For the shorter way of gaining credit with scientific opinion may lead far astray from good science. The quickest impression on the scientific world may be made not by publishing the whole truth and nothing but the truth, but rather by serving up an interesting and plausible story composed of parts of the truth with a little straight invention admixed to it.... A considerable reputation can be built up and a very comfortable university post be gained before this kind of swindle transpires—if it ever does....The tradition of science, it would seem, must be upheld as an unconditional demand if it is to be upheld at all. It can be made use of by scientists only if they place themselves at its service. It is a spiritual reality which stands over them and compels their allegiance.[7]

In the 1920's it was still expected that in every scholar the memories of a broad liberal education would linger vividly enough so that the "problem of the two cultures" brought up by Snow after 1940 would strike him as purely artificial. Forty years later we are constantly celebrating the triumphs of the natural sciences in changing man's environment while completely neglecting the question of how the hypnotized masses will like this new world when they awake from their trance and find that they do not understand a thing anyway.

SCIENCE AFTER 1940, "MISSION-DIRECTED"

In the meantime, something has happened that has destroyed most of the aristocratic aspects of science. The state has taken over science and lured into the profession thousands who before 1940 would have had doubts whether it would pay to join. A characteristic difference between fifty years ago and today can be seen in the professor's standard answer to the student's question: "Shall I go into the academic profession?" It used to be "No." If a man of twenty-two was not sure that nothing else would do, the academic career was not for him. The answer in our time is: "With your good grades, by all means. If you become disillusioned there is always the way into industry or administration."

The student now, in 1970, finds it difficult to believe that, at least with many of us in the 1920's, there was never the thought of having to hurry, or of having to publish results prematurely and more than once lest they be overlooked or taken over in their entirety by somebody else. Even important discoveries were left for a year or two in the hands of the man with whom they originated so that he could develop them according to his means and abilities. We used to say: "An apple already bitten into is not very attractive." The man who had the first bite was expected to keep and eat his apple. But then more and more people appeared on the scene who felt no compunction to bite quickly into every apple within reach and then often drop it just as quickly. It was considered very bad manners; but they were the men of the future. And now in the age of the citation index our old forms sound absurd and rather suspicious, as if we expected to hold patents or property rights on matters that are so obviously in the public domain as a published paper. We were, in addition, under the delusion that those who cared too much about public opinion or applause were at a disadvantage. We believed with Goethe that he is badly off who does not get his full reward for his efforts while working, long before his results are published (compare Curt Stern's *"The Journey, Not the Goal"* with Watson's *The Double Helix*[8]). From the point of view

of modern technical society, the egocentric, epicurean attitude, which in its logical extrapolation leads to publishing nothing but the best, must be strongly discouraged as an abnormal deviation. Today's society is not interested in the private intellectual pleasures of the individual, only in his exploitable results, no matter how preliminary or unimportant they may appear to him.

The phenomenal increase in the number of people whose work brings them in contact with scientific investigations has changed not only the image of the average scientist but also his motives and relationship with his colleagues. The latter are not fellows working in neighboring fields—their fields—but all too often are direct competitors engaged in simultaneous, absolutely identical, experiments. Not only has the ruthlessness of accomplished business techniques invaded the areas where industrial exploitation overlaps research, but this kind of behavior is no longer considered alien to science. The quick result in well advertised, that is in fashionable areas, is what counts. Whence this duplication or quadruplication of research projects, with the concomitant cancerous growth of the printed literature.

With such a large number of intelligent and energetic people attracted into science it has become more difficult to be original. If a scientist is responsible for a department or an expensive laboratory, he must keep it going with money he will not get unless he convinces the administration or some government agency that certain useful results are forthcoming. A six-year period without a publication, a not uncommon situation with great scientists in the past, looks suspiciously inefficient in an era where the "critical size" of a cooperative group is scrutinized and no worthwhile results are expected from the lonely experimentalist.

The biggest customer for scientific "facts" and lots of them—never mind whether it was fun or boring to obtain them—is the government. I am unable to retrieve the reference to the following quotation which expresses the situation admirably:

> Young, high-spirited practitioners of the scientific method deluge us with new inventions, discoveries, tech-

> niques and an endless sequence of new facts, mainly at the insistence and under the direction of such unscientific laymen who may be called the state, meaning government bureaucrats, industrial administrators, job-seekers and society in general. Sooner or later all these originally individual endeavors to enjoy scientific research tend to become mission-directed, because the means to continue in a more elegant or profound way with the research one has started requires that we get the understanding and sympathy of the one or the other granting agencies. We know, of course, that the review board consists of scientists who will value any kind of research for its own sake and will not look too sharply whether it will fit a pattern which happens to be the guiding one for this particular agency. But, nevertheless, in general, research in this country is mainly determined by what the people in power consider to be the best for the good of the country.

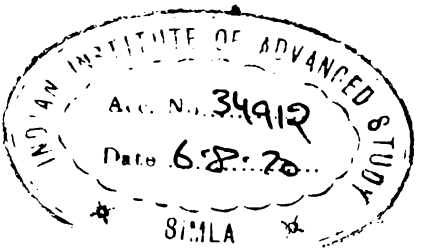
Today, in 1970, the call for mission-directed investigations "for the good of the country" reaches into the remotest corner of university campuses. Science and technology have largely become national institutions, and a large fraction of our available talent is in bondage to a government bureaucracy. The young men of today believe, of course, that this is the way things ought to be. To them, if they think about that at all, the free science of the single individual was merely a primitive phase, as primitive as the community of early Christians in comparison with the Church of Rome. But anyone who has wandered through those endless corridors, gone up and down the elevators in the enormous Washington buildings that house those who work to channel scientific inventions in the direction which is best for the country, cannot help thinking that he is in the midst of an organization which has developed its own rules for existence. Simone Weil once observed that "Every human group that exercises power does so not in such a way as to bring happiness to those who are subject to it, but in such a way as to increase that power."[9] The government demands directed research, the agencies whose existence depends on the government

will therefore follow suit. As Gaylord Simpson reminds us, "NASA —like the Defense Department entirely mission-directed...neither had any interest or any mission to improve the conditions of man's life here on earth or to make the continuation of that life possible."[10] And, I may add, neither had any church that makes the hereafter its primary focus. (See also Spinoza on law.)

> Oppressive regimentation begins inconspicuously with the imposition of restrictions almost everybody gladly recognizes as necessary and overdue. It proceeds with the imposition of a set of approved ideas and uniform standards of behaviour. Unless checked in time, it ends up by controlling everything.[11]

How much chance do the scientists have to retain that minimum of power (= money) which permits them to investigate problems the government is not interested in? With the demand for the obvious, the "crazy idea" has little chance of finding support. Who would propound a ten-year, full-fledged program well staffed and housed, financed on the level of a particle accelerator or minor moon rocket, to find access to a cure for a disease much more dangerous to society than cancer; a disease that afflicts all of us in various degrees, and insidious because it is rarely painful, certainly least painful to those who suffer most from it, in short: stupidity? Yet such a project is neither absurd nor anything like hopeless. In part it is already being supported under various aliases such as human genetics, educational research, psychology, diseases of the mind, literary essays on human understanding, etc., etc. Bernal wrote recently:

> The important thing in this is not so much the attitude of individual scientists as the collective effort to block out at least ideal policies which would have the general direction of making science serve the preservation and not the destruction of humanity. The more scientific effort is directed to military ends, the more resistance it will create in the minds of scientist. The awareness of the proper use of science in society is not easy to reach, and it is harder still to get agreement on it even among scientists...(The scientist) sees a world in which the use of science has become the dominating factor. Mankind



> cannot progress, cannot even exist today without science. However, far from giving him a sense of power, it emphasizes his awareness of his present weakness and futility. The powers of ignorance and greed distort science and lead it astray for war and destructive ends.[12]

Nothing illuminates the misunderstanding of the public about the role of scientific research as clearly as the recent notion of its representatives that for the benefit of the country (again!) the flow of funds in support of science can be restricted or turned off as if it were a road-building program. In an emergency, a temporary tourniquet to check blood flow can be put on at several parts of the body without causing permanent damage—except around the neck.

Intellectual adventurers and artists rarely produce something easily saleable that may sustain them if their usual general support fails. One has to see to it, therefore, that they continue to produce in order to maintain the flow of ideas that later determine the liveliness or dullness of a country's civilization.

EXPLORATION OF SPACE AND THE MAN-MACHINE

Though industry had partly broken with the tradition of the one-man program in science, namely the master and his pupils, so typical of academic research, the event that initiated a new phase in the history of mankind and with it a new belief as to the way scientific problems ought to be solved, was the Manhattan project. It demanded the cooperation of many first-rate men trained in a great diversity of skills. It also required such large amounts of money that only the government could support it. But its colossal success initiated the new style in the approach to scientific problems. The eradication of infantile paralysis was a somewhat similar example in the field of biology. And now we have the project to put a man on the moon. As everybody knows, the colossal venture succeeded. Yet two kinds of questions are rarely asked by those who in the end have to pay for such enterprises. For example, as to space: is that trip to the moon necessary? As to the idea that money and manpower will solve practically any problems: why was cancer not cured long ago? The public has not been properly told that crash programs on the grand scale can be expected to succeed in a foreseeable time only if some key principles in basic science have already been discovered and are ready for development. Only in such circumstances does it pay to seek for the final solution by the proverbial method of leaving no stone unturned. The obverse situation, to which I shall address myself later, obtains when we already possess fundamental scientific insights concerning profound problems which, however, the public or its leadership fear to see applied in real life, and therefore steadfastly ignore.

Without the decision of the two governments, the Russian and the American, to put a man on the moon, the exploration of space to the extent we have it now might have taken another fifty years filled with quiet yet exciting research for the selected few. Other choices for spending all these billions would have been to eliminate most pockets of poverty in this country and to redirect the funda-

mental misorientation of all that is called "education." A program for a balanced population could have been vigorously put forward, and the age of ruthless power politics and unimaginably stupid wars would thereby have been brought nearer its end for the benefit of everyone.

What has happened in reality has again been exclusively the concern of a minority—those who profit from this enterprise. The true benefit, the spiritual excitement, triumph, and wonder has accrued to the very few, the one per cent or less of the population who really understand the scientists, and to those whose imagination lets them grasp intuitively the new confrontation of man with his cosmic environment. The cooperation among scientists, engineers, and administrators has indeed produced the greatest technical triumph the world has so far seen. The nearer planets, Mars and Venus, are open for inspection. The research on the evolution of our planetary system, and, even much more important, that on the appearance of living things, enters an entirely new chapter. For the biologist this development is exciting beyond description. But mainly for one reason. We might receive a very serious lesson about man's place in the universe, namely that there is no speck of life anywhere within a distance of more than four light years. This would forcefully remind us that planet Earth has to be managed in its entirety as a life sanctuary.

Yet the others, the nonscientists and laymen, unless they are employees in some of these enormous government projects, will not have any tangible benefits from the conquest of the moon or exploration of Mars other than the satisfaction they obtain from hearing on the radio how their favorite team won in an international sports contest. Are the people of the small nations of Europe in any way worse off for not sharing the patriotic prestige of being citizens of a moon-conquering country? When these questions first bothered the community of scientists, the United States had not yet embarked on waging a full-fledged preventive war against a badly analyzed future threat in Asia. Now the expenses for our space sport pale in comparison with those spent to convert Asians to

democracy. Is anything more urgent than studies to understand why people *en masse* are so easily persuaded, yet singly so difficult to convince?

I urge the young scientist who has not yet made up his mind, to peruse carefully A. M. Weinberg's essay "Criteria for Scientific Choice."[13] At one point this author asks: "How can one measure the merit of behavioral sciences and nuclear energy on the same scale of values?"

On the political and technical aspects of the space mission we have an excellent critical literature. What has been neglected is the effect of the space mission on man himself. The space mission has produced a new creature—the machine-man. While La Mettrie tried to prove to his 18th century readers that man functions like a machine, we, two hundred years later, are showing experimentally that man can serve very well at least as part of one. The coming dehumanization of man was seen long before 1940. On the last pages of his second volume of the *Decline* Spengler described, forty-five years ago, how Western man has become the slave of his creation, the machine, which is going to unfold fully its secret devilish power in the years to come. Ortega y Gasset particularly detested the rise of the specialist. Chapter 12 of his *Revolt of the Masses* is entitled "The Barbarism of Specialization."

Ortega speaks of the disproportion between the complexity of present-day problems and the capacity of present-day minds.

> The majority of the investigators themselves have today not the slightest suspicion of the very great and dangerous internal crisis through which their science is passing. ...Now it turns out that the actual scientific man is a prototype of the mass man, because science itself, the root of our civilization, automatically converts him into mass man, makes of him a primitive and modern barbarian. The fact is well known....That state of not listening, of not submitting to higher courts of appeal which I have repeatedly put forward as characteristic of the mass man, reaches its height precisely in these partially qualified men. They symbolize and to a great extent constitute, the actual dominion of the masses, and their

> barbarism is the most immediate cause of European demoralization....The civilization of the last century, abandoned to its own devices, has brought about the rebirth of primitivism and barbarism....But if the specialist is ignorant of the inner philosophy of the science he cultivates, he is much more radically ignorant of the historical conditions requisite for its continuation. That is to say how society and the heart of man are to be organized in order that they may continue to be investigators.[14]

The following is from an article by Eric Fromm:

> The 19th century said 'God is dead.' The 20th century could say 'man is dead.' Means have been transformed into ends. The consumption of things has become the aim of life, to which living is subordinate. We produce things that act like men, and men that act like things. Man has transformed himself into a thing, and worships the products of his own hands. He is alienated from himself and has regressed to idolatry, even though he uses God's name. Emerson already saw that 'things are in the saddle and ride mankind.' Today many of us see that the achievement of well-being is possible under only one condition, if we put man back into the saddle.[15]

One more quotation—Aldous Huxley writes: "Industrial man, a sentient, reciprocating engine, having a fluctuating output, coupled to an iron wheel revolving with uniform velocity, and then we wonder why this should be the golden age of revolution and mental derangement."[16] Was it not Samuel Butler of *Erewhon* fame who said a hundred years ago that only machines progressed?

Scientists as a class of useful experts, like lawyers, doctors, and engineers, never had it so good. Few among them seem disturbed by the ominous tendency of man, Western or Asian, if he is only given the opportunity, to advance from a person who loves to play with machines into one who likes to serve them. Enough has been said about the tyranny of the automobile; but truly frightening is a new branch of human biology, which aims at changing a man, to remodel and squeeze and integrate him until he functions as a reliable wheel in the system. Long before we, the citizens of

this democracy, after intelligent debate, shall have agreed to finance an all-out program of human eugenics, to eliminate properly analyzed undersirable genetic traits and to conserve desirable ones, we may have succumbed irreversibly to our idolized machines without so much as one nation-wide debate. With an artificial kidney, a plastic heart and a sterilized soul (all already available) it will soon be possible to put a 10-year guarantee on a fully-brained machine. Unbelievable? Here is the official summary of a well-financed government program dated 1967:

> Human Factors Engineering focuses attention on the human component of equipment and systems, and considers man as an integral functional part of the man-machine conbination. Because of his superior capacity for sensing, controlling, improvising, and decision-making, man, when properly employed, has great potential for improving system performance. On the other hand, he may contribute to system degradation, particulary if his capabilities and limitations are not recognized and taken into account adequately during system definition, design, fabrication, and operation.[17]

Since the preceding paragraph was written, we have had another milestone of progress. A minister at a funeral of one of our 50,000 yearly automobile victims may in the near future console the parents with words reminiscent of those said a million times over the graves of war casualties: "Your son did not die quite in vain. His good heart continues to beat in another man's breast." Recently a moribund person has been eviscerated to increase the survival chances of four others. What is right and good for an intact organ we can expect, of course, to be right for any unique and vital extract from such organs; in short, we are back to cannibalism on a scientific basis. But still the Hippocratic oath forces doctors to keep a completely paralyzed man in a semiliving state at the expense of the finances and, more important, the sanity of his relatives. Instead of age-old trivia such as quibbling about pornography, our lawgivers should get busy with these awesome new questions which nobody has so far thought through properly.

This is only a beginning. In order to serve society better, what else will be done to us while we are alive? This last line may stimulate the reader's imagination: "Split-brain monkeys can handle more visual information than normal animals" (from an article by M. S. Gazzaniga on "The Split Brain in Man").[18]

On this planet the force called "Faustian" by Spengler drives Western man to continuous action even after his basic instinctive drives have been satisfied. This restless urge to mold a world according to his unfortunately quite limited imagination—this force has pushed man himself into a corner from which he must now try to liberate himself. At the moment it looks as if stupidity and meanness, combined with the forces of technology, are going to win the race towards cultural extermination before reason, in the form of biology and psychology, has had a good chance to discover the best way to reverse the trend.

The human psyche is fabulously complex, simultaneously terrifying and awe-inspiring; but so is the cosmos. To contemplate with deep emotion world and mind in all their transcendent glory and to reflect on this poetically and philosophically has been the core of a humanistic education. To develop a world view on this basis alone is, unfortunately, the way to extinguish all impetus to start working humbly and patiently on the exciting task of understanding the world more profoundly by the method of the "control experiment." The church was dead set against this insolent assault upon God's creation. Yet the success in changing our environment by a method which rests upon the pretense that we might understand what is lastly beyond all understanding has been overwhelming. The same will be true concerning studies of human nature. Surreptitiously scientists in many branches of biology are already at work. Since the public has no inkling what this is going to lead to, we biologists have not yet been burned. That some caution in the pursuit of such research is generally felt to be advisable may be guessed from Dobzhansky's remark: "It would not do for a student of human evolution to ignore the tragic human predicament, although scientists in general have prudently avoided coming to grips with such problems." The contrast to traditional teachings on the nature of man is sharply illuminated by the opinion of a psychotherapist, A. H. Maslow, who sums up some of the new insights by stating: "One conclusion...is a very revolutionary one, that no other large culture has ever arrived at, namely that our deepest needs are not in themselves dangerous or evil or bad."[19] Scientists must take care, therefore, to emphasize that a study of human nature is in perfect harmony with certain humanistic and religious ideals concerning our society. Science supports by typically demonstrable results some of our cherished traditional values which, when left in trust of philosophers alone, would not be altogether safe from the devasting attacks of purely logical analysis.

In old age, Herbert Spencer wrote (around 1904) about opin-

ions he had held earlier in his life. "Believing as I did that right guidance, individual and social, depends upon acceptance of evolutionary views of mind and of society, I was hopeful that its effects would presently be seen on educational methods, political opinions and men's ideas about human life. Obviously these hopes that beneficial results would presently be wrought, were too sanguine. My confidence in the rationality of mankind was much greater than it is now."[20]

Whose fault is it that so little was done before 1914 and between the wars to educate the people in a manner that might have preserved what was good in that now remote era? The historians' verdict will perhaps be that we scientists were, and still are, to blame. We chose to investigate everything in sight—with one exception, ourselves. The reason: cowardice. The vast majority of non-scientists considered such inquiries as an intrusion, an imposition, and a threat to the tradition of both personal comfort and public conformism, the latter an important component of the art of government. It was much safer, consequently, for a natural philosopher just to dream of progress based on the power of education—an education which would help only the few who like himself would anyhow remain powerless in the real world of political events. One need only read with what derision Spengler treats the political aspirations of the thinkers as compared with those of the doers.[21] I am aware that a prodigious amount of research is being done under such headings as social studies or child development or education or psychology. But these activities are supported so far by a tiny fraction of the taxpayers' money in comparison with what is given to particle physics, space politics, or the training of soldiers, the old art of inducing a man to kill without any personal reason whatever.

What will take great sums of money but is perhaps the most important task in the studies of human nature is to ascertain the true personality of "the masses." It may be just a superstition to assume that ninety per cent of mankind must exist naturally and forever on slightly subhuman levels of the mind, as the philosoph-

ers (Ortega), the historians (Spengler, Toynbee), certainly the priests, and many philanthropists seem to be sure. Maybe the unteachable fraction is only fifty per cent. Who knows?

Even in countries with such high levels of literacy as ours people do not read books. Too few have the opportunity to grow up as I did, surrounded by a thousand books. Nor do they receive as a matter of course reasonable, verifiable answers to whatever question may come into their heads at the impressionable and, as some psychologists think, crucial years before school indoctrination starts. Qualitatively, we all agree, part of the solution may be found right here. We know very well how to prevent malnutrition of the body, and sometimes get around to feeding some of our poor. But as to early malnutrition of the mind, we know precious little. It is quite possible that the traditional religious teaching might really do much more harm than we are aware of. He who does not trust the inherent reasonableness of people and their ability for deliberate judgment when properly informed denies among other things the rationality of our judicial system and should plead for the transfer of all proceedings at law to the computer (something I believe that for other reasons—such as speed—might represent a practical improvement). Recent changes in the definition of justice or the psychology of law enforcement, in the methods of education or the relationship between government and churches, etc., are attributable to a few courageous individuals who in their idealism persist in their endeavors. Most of us find our lives too short for the thankless task of pressing for obvious reforms.

And so it has come about that more money is being spent to make humans fit into a particular machinery than into their own society—or to remodel society to serve human needs better. The engineer has a very precise idea where he can fit a man into the machine which he invented with that purpose in mind, whereas the sociologist, after centuries of contemplating mankind as a whole, has only vague and timid ideas about when he ought to do to improve society. As for the ordinary man, he has no opinion

whether he should approve or disapprove of the engineer's tricks, which he finds thrilling, even if sometimes a little nauseating. But he has been indoctrinated with definite opinions about society and is opposed immediately to anything he has not heard a hundred times before. Sociologists know quite well where and why our society is ailing at so many places, but so far as I am aware it has not occurred to them to ask the biologists what the individual roots of these evils might be. To what extent does the average sociologist think as a matter of course in terms of evolution and genetics, or of imprinting during the first years of a child's life? It makes a difference whether one believes that what is worth knowing about human nature has been known for quite a while and is to be found for the greater part in the Bible, in poetry, the law books, and similar revered sources of knowledge, or whether one realizes that we have just begun to understand ourselves as a biological phenomenon. On the other hand, it would be foolish to reject certain forms of gaining insight merely because they have been practiced for thousands of years before our time without the benefit of scientific analysis. Just as in any other science, the reliability and limitations of the older methods to deal with human nature have to be reappraised. In this way, the old might be fitted to the new without leaving that crack Conant is so worried about. Obviously, the scientific outlook must also encompass the most enlightened views obtained in nonscientific fields. The humanities belong in any science about the nature of man. If this appears to be too vast an undertaking, we ought to have a look at what the computer may be able to do for us. The results from feeding literature, history, criminal codes, and law cases into computers might lead to the first objective appraisal of how much to expect from a modernized program of child and adult education.

Since I wish to entreat all young biologists to think twice before devoting their lives to problems less urgent than this one, I must point out that the need was seen quite clearly thirty years ago by Hogben. In a chapter entitled "Politics and the Science of Human Nature," he said:

> The leaders of liberal and of socialist thought on social questions have shown...little interest in the standpoint of the many eminent biologists....Since liberalism has its roots in a pre-scientific view of human nature, it has always been inimical to the objective study of human behavior....The rational view is that scientific study of the way in which patterns of human nature are conditioned is the matter of supreme importance if we wish to advance to a more rational organization of human welfare. There is good reason for believing that scientific ignorance has much to do with the crumbling away of our social tradition under the stress of economic disaster.... We shall not harmonize the public needs of a progressive society with the private needs of human nature until we have a science of human nature.[21]

Everybody knows that one cannot join the sixty-mile-an-hour rush of a four-lane highway at the supposedly safe speed of twenty-five miles an hour without causing turbulence, if not disaster. Yet we are expected to cope with the self-inflicted problem of an ever-accelerating technology with patterns of thought considered safe and proper by our forefathers.

Obviously, we must develop a new set of prejudices of a kind which remains workable and flexible, because they will be based on scientific insights instead of upon revelation of yesterday's eternal truths which, being too rigid, are likely to break down painfully under any real stress. We brag constantly about the progress made in the field of the exact sciences and remain dumb about those concerning political or emotional human interests. In the area of practical human relations there seems to exist even a superstition that truth and reasonableness must be carefully sidestepped if one's country is to prosper. (See the modern example in the aforementioned Arab-Israeli debate before the Security Council.)

Once the new tool, the analysis of human nature, is properly working, we shall know what we have done wrong during the last 2000 years and which is more at fault: the method of shaping children into responsible citizens, or the raw material, the species itself. If its present genetic makeup turns out to be beyond redemp-

tion, it will be recast either in the cruelest ways by nature itself, or by us on our own terms. The task which comes first and is more urgent than all others is to inform the people that these choices are theirs and that in a democracy it will take years of knowledgeable debate to come to an equitable solution of how to proceed.

The "wave of the future," the mechanization of our ways of life, is spreading around the globe. The universal dream is of a Western standard: a life expectancy of seventy years, soap and hot water, eventually books and the time to read them alone in a quiet room, preferably with a window looking out into a pretty garden. Very few know that this planet has only space enough to fulfill this dream for at best half the population already upon it. Anyone who can truly say that he is not much interested in the living standards that will prevail during his future years or during the life of his children is, of course, excused and need not worry about this amazing problem. But should he choose to worry, he ought to admit that any remodeling of our value system had better be thoughtful than thoughtless, had better be guided by studies on human nature rather than by fitful responses to human crises. Some will say that if a rational approach were possible it would have been tried before. This does not make sense, for it is only one hundred years since we have known that human nature is subject to change by other and more permanent means than just social coercion; for only fifty years have we known that what has been achieved with cattle, dogs, corn, fruits, etc.—namely the selection of better varieties—is perfectly applicable to man, if we could only decide what selection to make. But a science of educational psychology which promises to be the least dangerous way to start tampering with some of man's undesirable traits, is just in the process of being born.

To the extent that science and technology are shaping man's future, a scientist should be interested in doing scientifically what so far historians and political soothsayers have often confidently attempted: predict a bit of the future. By such predictions I do not mean obvious extrapolations of the development of machines and

drugs and what they will do for us (the usual content of science fiction), or predictions for the life of the individual which we must leave to the physician. A more important but attractive field for prophecy is to contemplate what may happen to society provided the newest of sciences, the study of human nature, is allowed to unfold with the aid of subsidies comparable to those now given to the development of particle accelerators or biological poisons, as well as active warfare. The seeds for a biology of the mind are sprouting everywhere and include intuitive psychology, brain surgery, biochemical drug experiments, and hypnotism.

No other science is likely to probe so near to the regions where traditional habits and superstitions, despite recent sociotechnological changes, have until now ruled unchallenged. Certain nerves in the body of Western culture have already been painfully touched, particularly those intended to transmit religious signals. Unchecked, they have grown into domains clearly reserved in the modern world for the rule of demonstrable instead of revealed truth.

The great difficulty is that if anyone even tentatively suggests that our great institutions ought to be analyzed from the point of view of already existing knowledge of man as a social animal, he will find himself immediately opposed by millions who cry out that their eternal values are being threatened.

Non-Catholics have no reason to feel particularly advanced, modern, or superior because their denominations have nothing to do with the recent scandal caused by the papal encyclical on birth control. Any fundamentalist belief, be it Christian or Islamic or secular, which demands absolute obedience to rules that have only mythical, historical, or metaphysical bases, is likely to produce similar vicissitudes for the lives of the faithful. In centuries past, people endured the misery stemming from enforced conformism in thought and behavior in the same manner they did their abject poverty, namely in "quiet desperation." There was no way to prove that certain religious demands were quite naturally and generally unenforceable, and that for this reason they generated unresolvable conflicts. The churches took advantage of this situation by inventing the notion of "sin." In our time, it can be demonstrated that it makes sense to stop at a red traffic light, and that in doing so one's sacrifice of personal freedom is slight. Or, with a little support from the police, we can see the reasonableness of the golden rule, which prevents most of us from committing murder without feeling intolerably frustrated. But to be told to stop making love is another matter, and in the age of the pill it seems plain foolish. While this most personal of problems is at the bottom of the present commotion about the pill in this country, my concern here is the magnitude of the harm done to all of mankind in terms of the population problem by insisting that well-established scientific knowledge should be ignored for purely imagined, easily refutable reasons. After reading an earlier version of my manuscript, good friends concluded from such lines as the preceding ones that I am dogmatically against all aspects of religion. Therefore, though it has been said so often before, let me restate the following. All civilizations, some completely alien to ours, have developed religious rites for complex emotional reasons science does not yet understand. We scientists have no desire to usurp a task which the churches have fulfilled always tolerably and some-

times superbly, namely to offer consolation for injustice and the senselessness of early death or lifelong misery; to heighten and dignify with beautiful and solemn rites moments of joy as well as of grief common to us all. Fiction, poetry, art, and religion are outside the scientific domain. They presuppose individuality, the uniqueness of each person, which, interestingly enough, modern genetics has demonstrated to be scientifically correct. Science, on the other hand, is based on common knowledge and mutual critique. It follows that personal truth and scientific truth have nothing in common but the sound of the word. Personal truth is part of knowing oneself and cannot be falsified by logical argument, while scientific truth remains believable only until it is shown to be not believable any more, whereupon it has to be amended and widened in the seams like an outgrown child's dress. For over a thousand years the theologians claimed to have all the answers about heaven and earth. And the greatest triumph of the Catholic church, to mention the most powerful institution, has been that Hume, Voltaire, and all the rest of her sworn enemies down to Sartre and Russell, could not put a dent in her armor. But now experimental biology and technology, with perhaps only a fraction of the intelligence and wit of the great philosophers, have given us answers about man's nature on earth which are overwhelmingly convincing. It is clear that the churches must stop dictating in detail how a man should live his private life and retreat for good to the tasks which are truly their own. The worst trouble comes when the churches hope to maintain their power over the daily lives and common activities of modern man by suppressing or withholding new information from their faithful, just as the communist political hierarchy does.

Young biologists should never forget that between the times of Archimedes and Hipparchus and the age of Roger Bacon, there were fourteen centuries of no science at all in the West. And when it finally resumed its growth, it truly flourished only in those parts of Europe that had been shaken up by the Reformation. The regions that were, and have remained, in the firm grip of a powerful

state church, such as southern Italy, the Iberian peninsula, and the former Spanish and Portuguese colonies in South America, are precisely the countries which have contributed next to nothing to the development of modern science from 1500 to the present day.

Geneticists will rightly protest any attempt to explain this psychologically interesting phenomenon on the basis of a different distribution of intellectual talents between north and south Europeans. We need only to remember the eminent explorers, warriors, writers, poets, philosophers, and artists who have come from the very same countries. It must be a matter of education and a continuation down to the present of the medieval form of thought control. Thus the perpetual resistance of the Catholic church has been to a great extent responsible for the fact that even in our predominantly Protestant country the necessary millions of dollars were not put into research toward the pill and for its cheap distribution at a time when it would have done much to avert what we have to contend with now. The famines we shall have to witness in the coming years will still be called "natural" catastrophies. Circumstances beyond our control, as we are so apt to say, will make it impossible to help India and South America with either sufficient food or pills. From 1923 on, the literature on birth control has increased steadily, together with the objective evidence that a liberalization of the law was not only desirable for humane reasons, but would soon become absolutely necessary. Every properly informed scholar who saw an opportunity to do so within the context he was writing about, has admonished his readers that this was the greatest problem not only in India but everywhere—and in the United States as well, if not yet because of calamitous economic pressures, then for reasons of human decency. A recent article in *BioScience* tells us "it is estimated that there are one million induced abortions annually in the United States."

Only a century ago a famine in India was clearly one of those unforeseeable Acts of God. In our time, the world, as represented by the delegations in the United Nations, or at least its FAO section, knows only too well that the occurrence and extent of famines not

only can be predicted, but also that there are means by which, at least in principle, such misery can be alleviated, if not prevented in the future. To the extent that we live in a man-made environment and have won control, at least partially, over the forces of nature, mishaps are no longer pure Acts of God, inevitable and unforeseeable. The concepts of right and wrong, of justice and guilt, become applicable when we know perfectly well what is going to happen but fail to take precautions.[22] If forty years ago those who had no conformist blinders and no reasons to be afraid of uninformed and bigoted voters had been able to convince our government to further quietly the research that Gregory Pincus was soon to start privately —in the same way the government now quietly works on means to control all of us by "humane" paralyzing gases—the story of this century would be moving toward a happier conclusion.

There is a simple way to bring natural philosophy and fundamentalist beliefs into workable agreement. The churches admit that the laws of nature are those of the Lord and that it is hopeless to try to circumvent them; that the true definition of science, as Simone Weil said, is "a study of the beauty of the world." Science, on the other hand, admits that no way has as yet been found to explain man's capacity to discover or invent natural laws, to meditate upon himself and his place in nature, or his power to produce art, and that thousands of years of introspection and intuition have given us rules of thumb about the civilized ways to curb as well as to cultivate our emotions. These old rules ought to be followed reasonably until there is scientific evidence that in this or that traditional form they are unsound and must be readjusted. The prospect that we can soon transform conflict into cooperation may be, alas, as dim as that of escaping nuclear war.

While the rejection of scientific views on human nature arises as a principle in any fundamentalist religion (Teilhard de Chardin was forbidden to publish; his writings did not appear until after he died in 1955) the harmful result comes with the all-pervading success of such authoritarian indoctrinations. Even in this republic things have changed since H. L. Mencken wrote around 1930:

"Alone among the great nations of history we have got rid of religion as a serious scourge, and by the simple process of reducing it to a petty nuisance. For men become civilized, not in proportion to their willingness to believe, but in proportion to their readiness to doubt." The power of religious custom is still such, in 1970, that no one can hope to be elected to an important public office if he lets it be known that he is an atheist and has no need nor sees a reason to join any of the fashionable denominations.

Most great religions were founded when human lives were short in comparison to the rate of cultural change. The world of the grandchild made sense from the point of view of the grandfather; they understood each other without taking courses in recent history. From the time the horse was domesticated until one hundred fifty years ago, man could not move faster over land than his mount. Now with six hundred miles an hour possible for man on the move, our lives have become very long in terms of environmental changes. For the first time in human history, we are clearly aware of being condemned to live in an age of furious and irreversible technological progress. And suddenly it has become apparent that the changes in law and theology, which in the past took centuries to mature, must be speeded up also to fulfill their social task of maintaining order while the flood of new knowledge and technical innovations is tearing many good old customs to pieces. For instance, consider the Vatican ecumenical council which raised so many hopes among the church intellectuals who are dismayed at what has happened since.

No doubt, well-established lawyers, judges, historians, and writers are people of highest intelligence and good memory. Of course they know who Darwin, Mendel, Freud, even Gregory Pincus were, and when asked would still be able to pass a routine college examination. Yet in real life they act as if they had never heard of these men who made a 2000-year-old tradition of thinking about man, his nature, and his habits nearly obsolete. The great change is taking place, not because what seemed well established suddenly was shown to be all wrong, but because the old view was

incomplete and one-sided, and in many ways antiquated. The office-holders and business leaders do not realize that the study of man has just begun, and it does not give them pause to think that their decisions may soon be shown to be based on false premises about the educability of man and on wrong concepts about what really moves him. Only when catastrophes come thick and fast do they tend to remember that their fellow intellectuals from the natural sciences have been lecturing, warning, cajoling, in short pestering them for years about the consequences to be expected because of their neglect of data which were all available in their own official files. Dismayed, the great leaders summon the scientists to give advice as "experts," as if the latter were conjurors with a bag of tricks from which the clever men of affairs were at liberty to choose just the one which would work a miracle according to their needs while leaving traditional views undisturbed. That these "experts" include the only group of men whom the future will remember as having lifted the spirit of humanity in our time above the level of century-old short-sightedness does not disturb the minds of the politicians. They are not ashamed to tell their voters that the naiveté in political matters of well-meaning intellectuals such as the Bohrs, Einsteins, Russells, Sartres, and Szilards, is only too well known. They do not realize that an occasional half-hour remedial lecture on the facts of terrestrial biology by people like Gardner or Udall or Harrison Brown or Warren Weaver do not really help. Quick stop-gap information can never replace constant awareness of the unique biological situation which now prevails for man on this planet. In addition, there is the disheartening experience of the apparent impossibility of convincing many writers and philosophers educated in the humanities of the error of looking down on science because, supposedly, it is the inventor of the hated machines, and to make them realize instead that science is really a new philosophy and not merely a technique. This is the reason why a good many of the intelligentsia side with those who are just plain ignorant when the question arises concerning reforms of the kind scientists are likely to propose.

The problems facing us are scientifically much simpler, sociologically much more difficult, than we usually imagine. Certain questions which have been prematurely discussed in popular magazines, such as experimental research about the meaning of race, or the inheritance and selection of particular traits, or how and when instinctive behavior erases civilized responses, are not yet everybody's business to know and to vote about. What is everybody's business to think about is that unless something effective is done, the world in 2000 will be a "human ant heap" swarming with 8×10^9 people. Here in the United States we are "looking forward" to the task of making at least 100 million more people happy, added to the over 200 million we already have. No congressman ventures to say that regulation of birth has to be incorporated into law.

I cannot praise highly enough the U.S. Department of the Interior Conservation Yearbook No. 2, titled *The Population Challenge—What it Means to America*, published in 1966. The text is challenging, the pictures are beautiful, and the price of $1.25 is an outstanding bargain in the publishing world. The publication is adorned with the following citations. President Johnson: "I will seek new ways to use our knowledge to help deal with the explosion in world population and the growing scarcity in world resources." Secretary Udall: "I am suggesting that the United States set an example of how to plan the best relationship of human beings to their environment, the man to land ratio which would result in the highest development of the land and of free men." President Johnson again: "The concern is not with nature alone but with the total relation between man and the world around him. The object is not just man's welfare but the dignity of man's spirit." Quotation from President Johnson's speech at the United Nations: "Let us in all our lands, including this land, face forthrightly the problems of our multiplying populations and seek the answers to this most profound challenge to the future of all the world. Let us act on the fact that $5.00 invested in population control is worth $100.00 invested in economic growth." Is this not wonderful? And where is congressional action? Compare the articles by Luck[23]

in *Science*, November 1, 1957, and by Kingsley Davis ten years later in *Science*, November 10, 1967. Secretary Udall's publication should be in the hands of every school teacher in the United States. The very beautiful illustrations and the good text make it first-rate teaching material. What would the rulers in the USSR do once they had made officially such pronouncements as those of our President; or printed a book as useful as that of our Department of the Interior? How can one say all the demonstrably true things and then quietly compromise with ignorance and superstition? Is that leadership? Today, in 1970, President Nixon and Secretary Finch in their respective pronouncements on pollution and birth control could well have given credit to their predecessors who formulated the basic problem in a well-nigh definitive manner. The true question remains: What will be done? The proper and reasonable things have been pronounced like words of a magic formula in the dutiful hope that—against all expectation—the right action might somehow follow. *Dixi et animam salvavi.*

> "Considered solely as an animal, man is just about the nastiest creature that has ever been evolved...not primarily through lack of good principles...but because he is increasing too fast and because of his ignorance and stupidity where he at least has the means to be far-seeking and sensible..."—Thorpe.[25]

Without respected parents and a reliable refuge in the home, children are likely to remain in their natural state—primates with a capacity for learning to speak and for imitating the tricks their elders use in order to survive. If the difference between one of those savages who exist by the thousands everywhere—not only on far-away continents—and one we call a civilized man is due mainly to environmental influences, we have obviously failed in our educational task. Should it turn out that such savage people can be made to imitate civilized behavior only under the threat of the police and never for any other reason, then rebreeding (which is far in the future) is the only solution. By contrast, the literature on revolutionary experiments in education is already voluminous. Such experiments are much less fearsome than genetical ones. An educational mistake will disappear with the individual and, before that, may be corrected by re-education or coercion during his lifetime. Mistakes in the course of some genetical experimentation that is sufficiently significant to be of lasting value can be caught only after the experimenters have died and the public has probably forgotten what it was all about. Compared with the latter, seemingly radical innovations in education are virtually harmless and, considering our increasing crime rate, long overdue. They are of undeniable ethical value and not Utopian at all. They only cost money—and for that reason those short-changed souls who unfortunately never had a modern education will vote against what is the most important spiritual task in any nation.

A national effort is under way to erase inequality in educational opportunities. Let us assume that this has been accomplished

and that the children of poor whites and Negroes in Louisiana receive the same instruction as the children of the suburbanites in New England. What kind of a good education will that be? An education the parents approve of because it fulfills what they always thought of as the ideal education for themselves? Yet if so much is being said about the need for reforms and for a better understanding of science, it will not be good enough. The parents are the problem. They must be made to see that science and technology are ploughing up literally and figuratively the grounds in which their own ideals once were rooted, and out of which grew their present beliefs of what ought to be. Obviously we must prepare our children to face the world of tomorrow instead of making them conform to ours. If this is understood, the transition of the new basis for teaching our children is hardly a problem.

When we have accepted a teaching plan based on the evolution of man, a story which finally culminated in art, religion, philosophy, and science (see the writings of von Weizsacker, Bronowski, Bohr, Tax) the results of several thousand years of metaphysical inventions can be put out of the way into the curiosity shop, where, of course, these beautiful fabrics must be preserved as part of the evidence of how the mind works. It is hard to get around the fact that over the last fifty years we have learned more about ourselves as a part of nature than in all preceding centuries together—and this at a time when the study of human nature has not quite reached its stride. Our schools ought to reflect this. Not to be misunderstood, I must say that today's fashion of teacher-sponsored science projects in high school competitions is little more than a corrupting abomination. It brings me letters like the following: "I am in the 9th grade. I heard that you have made life in the test tube. Please send me some and tell me all about it."

In the school system of tomorrow, all teachers, regardless of what they will teach as their specialty, must be conversant with the problems touched upon in the preceding pages. It is not a matter of curricula—that is for the experts to work out. It is a matter of obtaining the most intelligent, devoted, and courageous teachers

that can be found in the nation. As Barzini expressed it in *The Italians* with regard to his country, "I would spend every available penny of state money for the education of the young." Teaching ought to be one of the best paid and most respected professions, comparable to that of law. When I first came to the United States in 1931, I found in the Los Angeles *Times*, on the front page and nicely framed as a special thought to ponder, "An education enables you to earn more than an educator." I have pondered that ever since and am sure that today, thirty-nine years and another World War later, 95 out of every 100 people find nothing wrong with that sagacious statement. In earlier centuries the aristocrats treated the teacher of their children as a kind of miserable slave. This aristocratic spirit has now descended on our middle class. The truth of the saying can easily be established by comparing the income of school teachers with that of lawyers, physicians, or research professors. One of the many duties of the five per cent is to insist that we ought to follow oriental thinking and consider the teacher as the revered guide toward what is worthwhile to wish for in our lives. Again—should the unthinkable happen and teachers become honored as they deserve—we may then insist that they be natural philosophers to start with.

The ordinary state of mind of a teacher, his orientation towards life, determines how he will answer without long preliminary ruminations those frequently embarrassing questions of younger children. A teacher who knows that it is possible and quite customary to violate moral laws and get away with it, while it is impossible to violate natural laws, let alone get away unpunished for the stupid attempt, is sure to answer in a way which the child will discover to be reliable and in agreement with his experience. At least, the teacher should know that it is immoral to invent answers where there are none. Being told that innumerable phenomena are not fully understood by anybody, or for which different answers have been given at different times, might put the pupil in a state of mind that transforms him faster into a thinking being from one that only parrots what he was supposed to learn. Our school system, even in

some graduate colleges, gives grades for having a good memory and an ability with words, not for being sensibly worried at not having grasped the full depths of a problem.

If we cannot understand the nature of the electron fully, it is not surprising to find this to be true also for human nature. Children will not be mystified more when told that they are either all or nothing, according to their point of view about themselves, than by being told that God is three in one. Actually, from a cosmic viewpoint, mankind's possibilities and troubles are fairly easy to understand; and equally easy from the viewpoint of my own being, where nothing counts but I, while the rest is background. Everybody learns to shift these viewpoints unconsciously a hundred times a day according to outside pressure or his predilections. It belongs to the basic scientific training that a person be fully aware of this duality. The next point is one which no child has ever been told until the method of objective enquiry has made it evident: all that is, is natural, in both inner and outer worlds. What former ages called unnatural is either not understood, or infrequent, or unaccustomed, or impractical for the smooth running of social traffic. Red lights and police are inescapable, but only where and as long as the need for them can be objectively justified. They should not be left out of mere habit where we installed them in former times.

So far, education of children is based everywhere on the expressed or tacit assumption that man's relation to the world has always been the same and is not subject to change. If things are like that, it is quite logical that the child be confronted with commands as to its conduct in life which are absolute and not to be reasoned about.

Today the notion that we cannot step twice into the same river pervades everything, and, if we teach evolution (as we absolutely must, because it is the overriding fact of life) it is too illogical to persist with the demand that the child should believe in unchangeable eternal moral rules. There is no reason why one cannot teach that our present ethical systems, the Golden Rule, the Ten Commandments (perhaps in Szilard's extended modern version), the

Christian demand for responsibility and charity, represent the highest moral development of mankind so far. Nothing has to be altered except the wrong notion that this is now the end and no more refinements are possible.* To the contrary, in a world that extols change, development, and progress as it does, there is no greater moral obligation than to search for the causes of such mean and blind barbarisms as we witness all around us in our Western societies, while the loftiest moral principles we can think of have been preached incessantly since the beginning of the Christian era.

The trouble and misunderstanding which beset our teaching and our ways of thinking about science and technical progress, as opposed to the traditional role of the humanities, are on the whole as yet on such low intellectual levels (common sense levels, one might say) that it is not necessary to take recourse to the highest standards of refined analysis (see Russell, Popper)[26] in order to recognize the need for reforms.

Technology is conquering the world because it succeeds. Our future methods of teaching might do the same. It would be a great step on the road to peace to have the same teachings spread over the world for the same reason, namely that it succeeds in making people civilized. We listen incredulously when the Arabs explain their sacred hate against the tiny Jewish state and wonder why they do not instead turn their income from oil to emulate the Jews and make themselves comfortable. We shudder when we, seldom enough, recapitulate the rebarbarization of Italy, Germany, and

*Take for example the contribution of thermodynamics to the problem of death. It is an enormous change in outlook from any religious point of view when science asserts: of the two mysteries, birth and death, birth is by far the greater. Death represents practically no problem at all, while the phenomenon of birth—the appearance of living creatures—is awe-inspiring, in whatever way one prefers to think about. Death by contrast, has become a matter which belongs to the art of living: a question of style for the individual to resolve. Will this remark be construed as advocating to teach and indoctrinate the young in the good manners of choosing one's own way of departing from this world when the time has come? Once upon a time it was considered a great virtue to do this without much whimpering.

Russia under their respective tyrants, yet we seem incapable of imagining that this outcome might have been averted had our social science, together with a science of human nature, been farther ahead and been accompanied by a corresponding social technology, such as adding birth control to death control. But who among our high school teachers and so-called educators (a title often given thoughtlessly to the administrators of educational institutions) is aware that our new educational system has to be linked eventually with equally advanced systems in Europe and finally with those of all other member states of the United Nations?

One of the earliest steps and simplest to comply with to further the understanding between peoples would be that all states require of their teachers a knowledge of the principles and present efforts of the United Nations Educational, Scientific and Cultural Organization.

UNTHINKABLE THOUGHTS

The popular and illogical definition of an unthinkable thought is a rational solution to a disagreeable problem which, though demonstrably feasible, remains unmentioned because it runs contrary to all cherished beliefs and values. The public speaker thinks: "It will upset my voters—my congregation—the parents of my students. I shall lose my job without having done the least bit of good by insisting that they face the truth." Unthinkable thoughts have joined the sinful ones in the classification of thoughts that are better suppressed than developed. In contrast to sinful thoughts, the unthinkable ones are not pleasurable. They merely disturb our moral equanimity and ethical balance because they call for action, while we have no idea whether this action will be successful.

Scholars, thinkers, and scientists, on the other hand, thrive on them. Such men have trained themselves to think a matter through regardless of the kind of a nightmare that may thereby come into view. After all, one is never sure that there is only one solution to a problem. A much better one may be found later on. And the idea that a problem should be left alone because it will probably disturb his sleep is in turn "unthinkable" to the true intellectual.

Experimenting with social institutions.—Many of the troubles assailing us today may well be called eternal, for they are not too different from those that plagued our ancestors 3000 years ago. What is new are the solutions to such problems that have become available in our time through biology and psychology. Just as it took some effort to persuade people to abandon traditional quackery in favor of modern medicine, just as virtually every man now believes that the earth rotates once in a day, in clear contradiction to what he sees, so we must persuade the people that it is time to supplant some old prejudices by new ones. It is time that they learn to believe what they already know superficially about such matters as evolution, inheritance, psychology, or even physics.

The technical world has outpaced all norms of earlier ages.

Now even religions have to adjust themselves to changes in human conditions everywhere in the world, and ours also are in for revision. When objective science has become so influential, free discussion about the most suitable among religious ideologies and value systems is one of the conditions for civilized progress.

Because a few of the behavioral experiments performed in the laboratory with persons who volunteer as guinea pigs are harrowing and often somewhat painful, the thought persists that much greater and unforeseeable damage to society may result if we experiment deliberately with social institutions and populations in the open. People forget that customs, fashions and morals change all the time (unless protected by law), not because of farsighted intention, but rather in the manner of contagious diseases. It stands to reason that the clumsiness of our judicial procedures, particularly in reversing decisions that do not work out right, are the source of much avoidable unhappiness.

One of the most talked-about among our social shortcomings is the phenomenal increase in costly divorces after acrimonious infighting. What great harm, may I ask, will result if in addition to the old form of marriage for life, a marriage license is offered which expires after five years unless cause is shown why this marriage should continue? With the arrival of children, the temporary form automatically reverts to the traditional one.

What harm will be done if unwanted and unloved children, of whom there are plenty, are collected into many small orphanages which, in addition to the usual staff, accept volunteer girls whose duty consists in dispensing attention and kindness to the children? These institutions would not be only charitable but provide urgently needed information about the "nature and nurture" problem. Mothers who have given up a child would be instructed to use birth control under penalty. This would prevent careless abuse of these social institutions.

Under present laws, some criminals must be fed for life in prison or electrocuted, hanged, or poisoned, sometimes after years of barbarous on-again, off-again trials. What harm would be done if

such a criminal were given a handful of sleeping pills to use at his convenience? Anyone can think of more of such harmless and possibly very beneficial social experiments.

Population policy.—The first ethical duty of the state must be to prevent the birth of children who are unwanted, not eagerly expected by loving parents, and for whom there will be no place in school and no good teacher. Such a demand was indeed Utopian fifty years ago. In our time it is merely the realizable extension of the privileges of the rich to all citizens—namely the right to be left unborn. For a small minority, this thought has become nearly trite, while the overwhelming majority have not heard it expressed even once. The current literature offers a large choice of paraphrases on the same theme. Here is one example from an article by A. B. Kinzel,[27] former president of the Salk Institute in San Diego. "Obviously important social decisions will be needed. The implication for society, if we lick the problem of aging, is staggering. It may be necessary to penalize someone for giving birth without a permit, as heavily as we now penalize an individual for murder."

Despite all "progress" the absolute number of the destitute on earth has quadrupled since 1800. There is no major social problem which would not become much easier to solve if instead of 4×10^9 we humans were only 2×10^9. The latter is still a very large figure, but reduction of the present number of people to one-half would give such a relief from all kinds of pressures that the world would perhaps be willing to listen to reason and truth instead of to fanatic or ridiculous lies. Yet people do not want to hear that if they are continually and hopelessly unhappy it would have been better for them not to have been born, and that even if they are happy, plenty of others consider them expendable. We hate both being crowded and being lonely. In its most primitive terms, the solution to this dilemma is simplicity itself. We humans who in our present numbers are the plague of the planet must be thinned out until we again begin to feel a need to cooperate with and to love one another. There are three prescriptions to achieve this: the bomb, the gas, and the pill.

And this brings up another point which illuminates our current hypocrisy from another side, namely the much vaunted "dignity of the individual." Great demagogues who seek to curry favor with the masses assure them of their individual dignity, particularly each time they intend to treat them as rabble. As one among four billion a man is absolutely nothing. Any commodity in such abundance is cheap, next to valueless, not commanding respect. Understandable, therefore, that the average man seems to care so little about how many of us are maimed and killed either in traffic accidents or political accidents called wars. To what extent inherent personal dignity has a chance to unfold depends, like evolution itself, on the capriciousness of fate which alone determines whether the individual differences in the genetic blueprints will find the opportunity to manifest themselves in real life.

The trend towards biochemical warfare.—World War III is in the process of being staged. The reason why it has not started already is that nuclear weapons destroy not only living things but also the precious machines, without which the surviving "developed nations" would find it difficult to "develop" any further. In other words, nuclear war is plainly too stupid an affair, even measured on the known high level of stupidity and meanness which were needed to bring about World Wars I and II.

But there is a very rational solution to this dilemma: biochemical warfare. This, of course, has long been seen by the clever among those in power. It is absolutely ideal. It will wipe out quite specifically millions upon millions of *Homo sapiens,* while leaving the machines intact. In the age of automation, it is obvious that one-quarter of the usual crew will suffice to keep our beloved civilization going.

That the Russians say nothing about their progress in the methods of biochemical warfare is to be expected. But in our free society, the tremendous strides toward the mastery of biological and chemical mass killing should not be hidden from the public as if it were something to be ashamed of. Because a free distribution of birth control pills all over the world is considered expensive and

immoral, it will not receive the necessary funds in Congress. The second method to save civilization while disposing of the surplus of mankind should therefore be duly praised. It is pretty certain that it has had already quite good financial support. The public is entitled to be sufficiently informed in order that it may look forward to this logical replacement for the bombs. On the other hand, the preparations have not reached the final stage yet. Thus we still have a breathing spell to consider whether letting other people starve might not be the more natural, as well as cheaper, solution.

On breeding better men.—"Man is the only domesticated animal not bred for his attributes," says A. E. J. Engel in a recent article very much worth reading.[28] If the root of all evil is to be found in human nature, the advice of the scientist is as simple as it is fundamental: let us change it. This can be done easily under one condition: that people believe truly what they already know to be true. This sounds like a formula out of a fairy tale, obvious and mysterious at the same time. Schopenhauer put it this way: "It is the perversity of the heart which prevents people from solving a problem their intellect could easily cope with." These things can be done stupidly or intelligently. In themselves the practical decisions to be made are ethically neutral, either rational and correct or irrational and very likely false. Remember the English literature class? "There is nothing either good or bad but thinking makes it so."

Among biologists the recent writings on this question ought to have become well known because they are not only exciting but also exceedingly well written. A few references may suffice: Sonneborn's *The Control of Human Heredity and Evolution*;[29] Kingsley Davis' "Population Policy: Will Current Programs Succeed?"; Paul R. and Anne H. Ehrlich, *Population Resources and Environment*.[30] I was, however, surprised to see that a great geneticist has not been quoted with the very important point that nations made miserable by overpopulation might become mentally incapable of deciding on the right course of action. This way of thinking looks very new and modern to those who are now in the midst of their

studies. Will they be able to place and date the following quotation? It is so timely because it considers the problem of breeding better men "for a society grown so large that only the barest livelihood is possible for most of its members."

> Here we can fancy that all the energy and thought of each individual are concentrated on keeping alive. It seems unlikely that much concern would be given to the difficult problem of discovering and fostering new types. If intelligent understanding of the problem is the means by which man is going to direct his future evolution, success seems more likely in a highly organized society limited in numbers....It is the leisure class at present that shows little concern with problems of this sort, and if its members are not sufficiently interested to look after the future of their own breeding, how can they be expected to become actively engaged in altruistic plans for others?...It is conceivable that if man undertakes to direct the evolution of his race he may blunder badly.... Why not trust the natural process to do all that is possible under the circumstances? This may or may not be good advice, but let it not be forgotten that man by his ideals as well as by his blundering and selfishness and lack of social consideration is now determining his future by active interference for good or evil with the course of nature. He may not be able to map out his future, but he has shown at times an astonishing power to interfere with what is taking place.

So wrote T. H. Morgan in 1932.[31] As to what biologists may eventually be able to do, these are the observations with which Morgan concluded his book: "(Mechanists) resent the boundaries set to their progress by metaphysicians. They even question the finality of the decisions of the metaphysicians....In the systems with which biologists have to do, biologists will no doubt willingly take over the new physics and apply it to their own field, whether it is called mechanistic or by some other name.

"The boldest spirits among the mechanists go further, and claim that in time they hope to bring within reach of their methods a study of the lucubrations, hallucinations and obsessions of the

human mind which masquerading under the illumination of introspective metaphysics and transcendental philosophy pretends to solve all the riddles of the universe."

Better leaders for the great society.—Communism-Marxism has the distinction of creating the idea of analyzing, planning, and experimenting with society as a whole. Few Americans realize how much Marxism has crept into their minds. The notion of systems analysis for the benefit of business has become generally accepted.

In 1905, Santayana wrote: "We cannot, at this immense distance from a rational social order, judge what concessions individual genius would be called upon to make in a system of education and government in which all attainable goods should be pursued scientifically."[32] Sixty-five years later we may wonder whether this distance has diminished in any way. To the extent that the state has taken science into its own fold and shaped it into an indispensable tool for its own purposes, including the servitude of men towards machines, one can say that it has. No science in itself can be irrational. On the other hand, an impact of scientific thought on the human elements within the structure of the state can hardly be detected. The administrators pay the scientists and not the other way round; thus they feel superior and remain as benighted as they please.

While everybody else must prove his competence to his peers by passing rigorous examinations if he wants to become an engineer, a judge, a physician, a druggist, or an appointed government expert, all a politician has to do is to appear good enough to the thoroughly incompetent voter. Can one imagine the Schlesingers, Galbraiths, Gavins, Morgenthaus, Rabinowitches, Restons, Cousins, Goldbergs and Kennans passing on the qualities and competences of one who desires to present himself to the people as a candidate for high office? An unthinkable thought—but what a gain for the nation if it became thinkable.

The threshold of ability which divides competence from failure goes up with the power of the office, *i.e.*, with the potential damage a man may do by having less than the required education

and imagination. If most human affairs expand exponentially, the effort to comprehend what is going on must follow in the same manner. Government by consent of the governed becomes an empty phrase if what is required of a statesman lies far above the heads of those who vote him into power.

Looking at the earth as a limited piece of real estate revolving under him as if he were an astronaut, the statesman cannot escape the duty of meditating on the ways to establish at least a minimum of world order, a world government. Considering the recent festival of lies at the Security Council, the idea of a world government, much discussed during the days of Hutchins and Borgese at the University of Chicago, has since been removed among the unthinkable thoughts. Yet a very simple attitude can bring it to the fore again: respect for the great minds of our time. Let me quote a government expert, Rexford Tugwell:

> It is not grossly inaccurate to describe the world's troubles at present as the inevitable adjustment of obsolete institutions, both political and economic, to technological imperatives. The more quickly the means for flexible adjustment and readjustment are devised and agreed to, the more quickly can peaceful progress be resumed. It is important that people of the West—that is, if we care especially about the West—should take the lead in shaping these adjustments rather than that they should persist in defending obsolete institutions for their own sake. Those institutions give every indication of being incapable of bearing the heavy load relentlessly being thrust upon them by the increase of the world's people and by the demands among them for equal and higher standards of life. If institutional obsolescence is not recognized in time the inevitable readjustments may be revolutionary; and modern revolutions have a frightening tendency to end in dictatorship of one sort or another.[33]

Economics in a stationary or balanced society.—While finishing this manuscript, I came across the following newspaper notice (*Guardian Weekly*, September 19, 1968): "So the end of the world is at hand, after all. The news from Paris, which emerged from a

UNESCO symposium, was that within two decades our planet will be suffering from the effects of industrial pollution; that the atmosphere will become unbreathable, and life will cease in our rivers and lakes." In the past, laymen often have asked me whether studies of photosynthesis could not lead to a solution of the population problem. Therefore I wrote in 1946: "Since this globe offers a certain area of habitable and tillable ground, it is obvious that populations will have to be adjusted to an optimum density determined by the general standard of living that man is capable of attaining or willing to endure." Twenty-five years later this is still obvious only to the same five per cent of the population to whom it was obvious a generation ago.

During the last quarter century M. K. Hubbert, the geologist, has repeatedly tried to draw attention to "The greatest problem" as F. L. Lucas has called it. He, Hubbert, wrote me recently:

> If we do not destroy ourselves we shall be forced to achieve some sort of an ecological and technological quasi-steady state. However, I am convinced that such a state of non-growth will be so completely incompatible with our present culture that one of the greatest intellectual revolutions of the last 500 years will almost inevitably occur as a consequence. I anticipate that it will be comparable to, but more sweeping in its scope than, the two great earlier revolutions, the astronomical and mechanical one of Copernicus, Galileo and Newton and the geological-biological one of men like Hutton, Lyell and Darwin. In particular such subjects as present-day economics will be viewed in retrospect, after some rationality based on scientific knowledge has been achieved, in much the same manner as scientists now look upon alchemy and astrology.[34]

What disturbs me now is that this particular problem of how much we shall be willing to endure has apparently been neglected by the most prominent economists. From Burnham to Galbraith, authors have reaped fame by analyzing the structure of our present economy. Serious, carefully calculated, theoretical models of a non-expanding economy for a stationary population are missing. Here

the only gains possible are free time (convertible into health and knowledge) and products of better quality. "A steady state is compatible with creative changes...; a closed system will probably offer intellectual...possibilities much more challenging than those offered by the kind of rampant growth that has prevailed during the past century" (Dubos).[35]

One reason that such studies have not emerged may be that they become plans—and a planned society is taboo. Yet hardly any of the problems raised in the preceding pages will find a rational—let alone optimal—solution unless society as a whole has become conversant with the ineluctable future economic exigencies and the possible ways to handle them.

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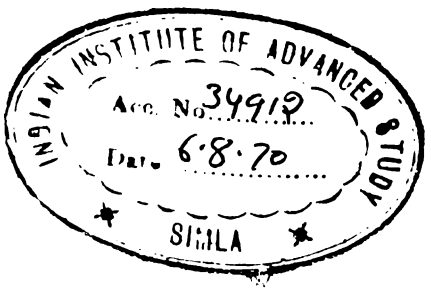

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