

BIOLOGICAL ENGINEERING AND THE BETTER LIFE — MORE OR LESS

HENRY M. BORSOOK

Professor of Biochemistry

It is a commonplace that engineering — mechanical, electrical and chemical — has changed our world. These changes have consisted essentially in the breaking down of the spatial and temporal barriers which confined our forefathers, of providing us with an enormously greater diversity of materials and of many more possibilities of diversion and distraction. Within our homes we can turn night into day, summer into winter, talk and see across continents.

A great invention induces disturbances in the established balance between ourselves and time, space and materials. In a successful society the reaction to this disturbance is the quick attainment of a new steady state in which we are better off; that is, we obtain more happiness than misery from the new invention. Walter Lippmann after a visit to the New York World's Fair wrote:

"The human race is a collection of the most marvellous, ingenious and engaging idiots that ever got possession of a noble planet."

The fantastic facility of transport and communication we possess today should have knit the world into more and more of an organized unit. Someone with his head in the nineteenth century wrote that:

"the provision of facilities for the free and prompt interchange of ideas will slowly but surely destroy those misunderstandings between men and nations upon which conflicts are built."

It would be flogging a dead horse to set out in detail the course of the World War which has been raging with continually increasing intensity since 1932. It may not be utterly futile yet to point out that within the United States barriers to trade between the states are now being wilfully multiplied.

Biological inventions have been, I think, even more important than those based on chemistry and physics. An important biological invention can go much deeper; it can affect our conventions regarding "right" and "wrong"; it may change one of the taboos which give society its character.

A biological invention is a change which disturbs the relations between human beings and plants and animals or among human beings themselves. Everyday examples are the domestication of animals, plants and fungi (for fermented liquors), the manufacture and wide use of bactericidal agents, the artificial regulation of the human birth rate, the manufacture of food materials, sex hormones, vitamins, textiles and dyes instead of growing them, the use of caffeine, alcohol and tobacco.

There is the same implication in biological as in the other forms of engineering that Nature's uneducated biological ways

are not perfect. We can improve on her. We now have more desirable plants and animals as a result of crossing and breeding; better nutrition, hygiene and preventive medicine have made us taller, healthier and longer lived. Immunity to mortal disease is sold in bottles. Someday let us hope we may be able to induce immunity against the neurosis of original sin.

The great advances in biological research have had an additional effect which comparable advances in chemistry and physics have not had; they have repelled superstition and lead us toward rational, if deflated, views of ourselves. Darwin demonstrated man's proper place in nature; the physiologists and psychologists are removing illusions regarding the mystic wellsprings of our emotions. It will be interesting to see what the teachers of ethics and morality make of such facts as that the maternal instinct depends on the presence in the blood of a hormone (a protein) secreted by the anterior pituitary gland.

Present biological engineering may be subdivided into three classes: the improvement of physical health and the prolongation of life; the provision of better, more abundant and varied food; and the discovery of the causes of unhappiness and how to reduce its incidence.

PROGRESS OF MEDICINE

The Progress of Medicine has had as deep an effect on the Occidental world as the Industrial Revolution. If African sleeping sickness could be eradicated it would be the equivalent to the discovery of a new continent, so large would be the new territory opened to human habitation. Four hundred years ago most human beings died in childhood. The infantile death rate in English slums today is one one-third of what it was in the English royal family in the Middle Ages. In the last thirty years alone the expectation of life has been increased by more than ten years. The students in American colleges today are one to two inches taller than thirty years ago. Animal experiments indicate that an increase in size obtained through improved nutrition is accompanied by improved vigor and longer life.

The most important medical advance, so far, in this century has been in the field of nutrition. More than a hundred million human beings are crippled with diseases which we now know to be nutritional deficiency diseases.

One of the latest findings in nutritional studies is that health is more than the absence of disease which shows itself in striking signs and symptoms: For example, three to five times as much of the vitamin B complex is required for satisfactory gastrointestinal function as for the prevention of beriberi. When good health is used as a criterion about half the population of England, it was found, is malnourished. This is one of the reasons



The library in memory of William G. Kerckhoff in the building of the biological laboratories.

that an incompetent but well fed governing class can hold on to office in that country. A nutrition survey in Pasadena indicated, and the findings here are probably typical if not better than for the country as a whole, that nearly half our population is obtaining insufficient vitamin A and one-third insufficient calcium and vitamin B. Nearly half our children under five show some of the stigmata of rickets, although vitamin D, which cures and prevents this disease, was discovered more than twenty years ago. It is now quite cheap and easily available.

The English survey showed that as income increases disease and the death rate (among the young) decrease, children grow better and taller, adult stature is greater and adult health is better. Improvement of the diet of the low income groups is accompanied by improvement in their health and growth, and their mental attitude approximates that of the higher income groups.

In order to give a child born in a poor family the same chance of good health and physique as in a well-to-do family it would be necessary, according to Orr, to increase by only twelve to twenty-five per cent the consumption of milk, eggs, butter, fruit, vegetables and meat. It could be done more cheaply by the distribution of synthetic vitamins, concentrates and mineral salts.

There are some items in the red in this section of the ledger in addition to the consequences of negligence and lost opportunities. One is that the population as a whole is getting too old. There are now relatively more old and fewer young people than a generation ago. Medical discoveries and preventive medicine have prolonged life and health; the spread of contra-

ceptive practice has reduced the size of families. This reduction is not equally distributed. There are more children in the poorest classes. Inevitably these children are less well educated and in general less fit. This population trend would be rational in a totalitarian state; for democracy it is suicidal. The alternative is, of course, for democracy to see to it that the children of the poor are as well fed, and given equal opportunity for development, as the well-to-do.

The unprecedented rise in the European population at the end of the nineteenth century was necessarily accompanied by a similar increase in the demand for meat and cereals. Agriculture became in vast regions not a way of life but an industry for profit. With tractors and combines the soil was opened to the forces of wind and rain until it was blown away. The story of soil erosion in America is being repeated now in the native communities of Africa and in India.

Society rightly applauds a Pasteur, a Koch, a Banting, or a Minot. Their discoveries are important for the health of the individual and they prolong his life. For the continuance of a healthy society there should have been some intelligent protection against the social unbalance which arises from the uncontrolled operation of the forces loosed by scientific discoveries. Medical discoveries are not different from others in their potentialities for causing social trouble.

Turning now to the second category of biological inventions, the biologist, the chemist and the mechanic have taught us to grow more food on the same amount of land with less labor. In 1913 the world consumption of fixed nitrogen was about 540,000 tons, of which the Chilean deposits supplied 477,000

tons. In 1934 the total was 1,500,000 tons, of which 140,000 tons came from Chile. The use of tractors, combines, new and better varieties of plants (for example, Marquis and Garnet wheat which can be grown in the Arctic circle), are the salient features of the best agricultural technique up to about 1930.

These were the first steps of a toddling infant compared with strides which could be made with the discoveries made in the next decade. The Russians discovered that by a judicious preliminary freezing the subsequent growth of a number of seeds can be greatly accelerated. Plant hormones (rather simple substances made synthetically and now commercially available) added to the soil with the water or mixed in powder form with the seeds before sowing increase significantly the size of common crops.

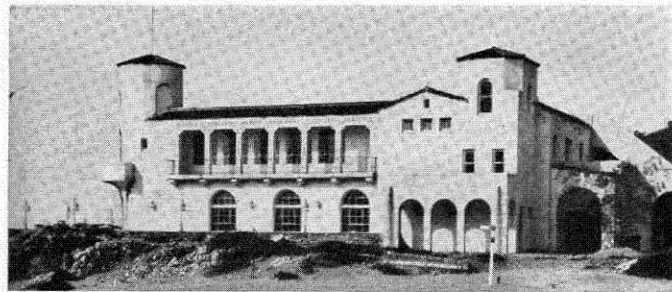
SOIL-LESS PLANT GROWTH

The soil-less growth of plants for the most part is still in the laboratory stage. But it need not be long before a city could grow much of its food, probably all of its fruit and vegetables, on its roofs. Now tomatoes are grown for market in tanks containing a salt solution of known and controlled composition. By controlling the climate (temperature and humidity), the CO₂ tension, the spectrum of the light, by adding hormones and changing the salt composition, we can be freed of the thrall of the seasons and of the limitations of uncontrolled natural conditions.

The organic chemists of the last half of the nineteenth century took the manufacture of dyes away from the field to the factory. The chemists of this century are doing the same with our food, textiles and fabricating materials. Seven vitamins are now more cheaply synthesized in factories than grown in the field. Sex hormones are made from extracts of soy bean. Will the history of wheat growing run the same course as that of the Indian indigo dye agriculture? The handwriting is on the wall for our large-scale commercial growth of cotton, rubber and silk.

The forms of applied biology discussed so far take no account of the mental and emotional condition of man. It has been assumed that less work, more comfort and diversion have made him happier. Have they? Half the hospital beds in the United States are occupied by mental patients. Prolonged emotional tension, conscious and subconscious, is one of the frequent causes of such common organic diseases as essential hypertension and peptic ulcer. Psychiatrists, Christian Scientists and faith healers of many dogmas are now as numerous as practitioners of any other branch of the healing professions.

The advance in neurology and psychiatry has been less than in any other division of medicine. Some promising leads have been opened up in the last few years. Ten per cent of the inmates of our mental hospitals are pellagrins. Pellagra is now a curable vitamin deficiency disease. The "hill-billy" mentality, which is chronic pellagra, is more difficult to get at. The shock treatment for schizophrenia with insulin, metrazol or anoxia



William G. Kerckhoff Marine Laboratory of the Division of Biology at Corona del Mar.

has returned to a useful if not quite normal life many individuals who were apparently hopelessly insane.

It is possible now to produce neuroses in experimental animals. In a susceptible animal a neurosis is induced by forcing on it repeatedly a problem which it must solve and yet cannot. One of the important attending conditions in the production of this neurosis is that the animal's freedom of movement must be restricted. It is interesting in this connection that every social order in Europe has derived the sanction of its authority from the promise it offered of freedom — religious, intellectual, political, or economic — and equality, if not in this world in the next. The anthropologists may be able to tell us to what extent congregation in cities predisposes one to a neurotic breakdown.

Some years ago the Bishop of Birmingham (England) called for a ten year holiday in scientific research. Presumably he was in favor of paying scientists for not doing research. His argument was that no one can keep informed of all the new discoveries and that too many discoveries exert an unhealthy disturbing influence. We need time to catch up and take stock.

There are some good points in the Bishop of Birmingham's case. Harm has come from the failure of social and political development to keep abreast of technological developments. But what is needed is not a holiday in scientific research, but more and better social and political inventions. We now accept the use of checks for currency as a commonplace; it was a great invention. Familiar inventions of our day are the T.V.A., the Food-Stamps Plan, the British Broadcasting Corporation.

Sir William Bragg has complained of the exclusion of the scientist from the council chamber, that he is kept in the ante-room and is called in only as a technical expert, that he has no voice in the framing of policy. Most of us will agree with Bragg. But it is well for the scientist as well as the politician not to forget that although the natural sciences have created the opportunity for a more abundant and better life, the advantageous use of this opportunity for the benefit of the whole of society is as much a matter of mind as of materials and forces. When the philosopher is king it will be well if among his ministers are a biologist and psychologist as well as physicists and chemists. The psychologist especially can be a force for health and happiness in a good society or he can be like Mr. Goebbels. The psychologist, as any scientist, is useful in any constellation of cultural taboos.