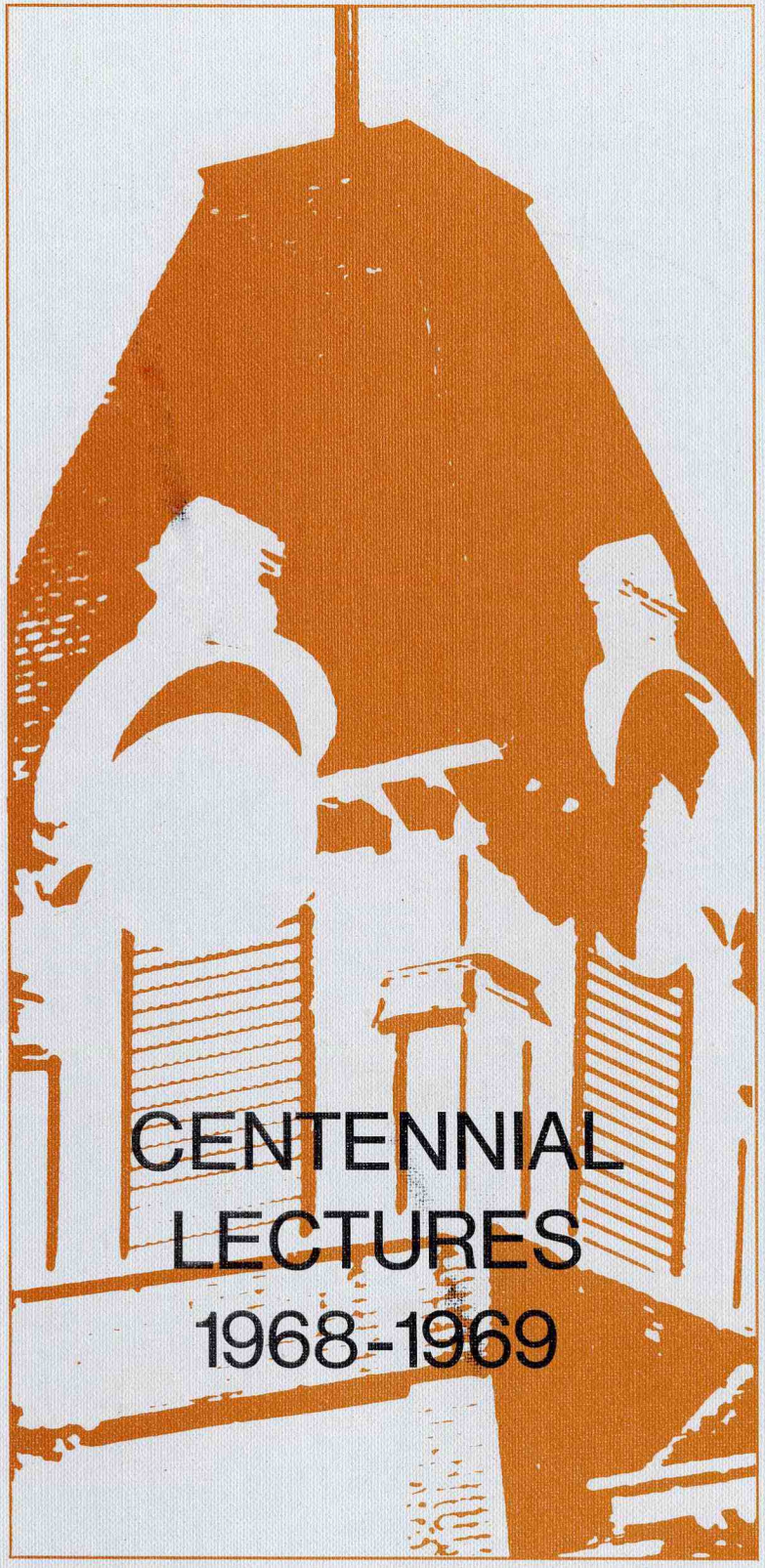

CENTENNIAL LECTURES 1968-1969

OREGON STATE UNIVERSITY

Oregon State University CENTENNIAL LECTURES 1968-69

Centennial Lectures
Oregon State University
1968-1969

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The Second Hundred Years

Published for

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PREFACE

James H. Jensen
President, Oregon State University

THIS collection of lectures is a significant addition to Oregon State University's Centennial. The year-long Centennial observance opened with Charter Day on October 27, 1968, included a three-day Centennial Lecture series on February 25-27, and ends with the Centennial Commencement on June 8, 1969, when the 100th class to receive degrees from this institution is graduated.

Charter Day commemorated the 100th anniversary of the day in 1868 when the Legislative Assembly of the State of Oregon designated Corvallis College to receive the benefits of the federal Morrill Act of 1862. Two distinguished land-grant university presidents were invited to speak on this occasion. Dr. Fred H. Harrington of the University of Wisconsin addressed the Charter Day Convocation and Dr. W. Robert Parks of Iowa State University spoke at the Charter Day Banquet.

The six eminent speakers, invited to deliver the Centennial Lectures in February, were selected to provide critical assessments of higher education and a broad look ahead at scientific, technological, political, sociological, and educational developments at the beginning of Oregon State's second century.

I wish to express my sincere and genuine appreciation to all of the scores and scores of faculty members, students, alumni, and friends who have devoted so much time and effort to this very successful Centennial observance. Special recognition should go to Rodney K. Waldron, chairman of the general Centennial Steering Committee; Rudy M. Kallander, Charter Day chairman; Roy A. Young, Centennial Lectures chairman; Wallace E. Gibbs, Centennial Commencement chairman; and their respective committee members.

Corvallis, Oregon
April 8, 1969

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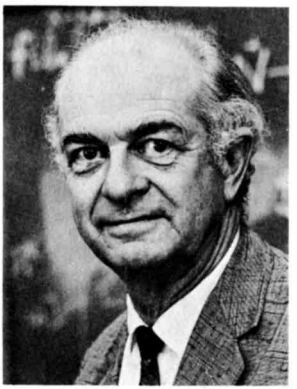

Dr. Linus Pauling
University of California, San Diego

LINUS PAULING is the only person ever to receive two individual unshared Nobel Prizes—in 1954 the Nobel Prize in Chemistry for research on the chemical bond and in 1963 the Nobel Peace Prize for his efforts to reduce international tension and promote peace. A native of Portland, Oregon, Dr. Pauling is a graduate of Oregon State University. He received his Ph.D. from California Institute of Technology, where he was a member of the teaching staff for 41 years. From 1963-67 he was Research Professor of the Physical and Biological Sciences in the Center for the Study of Democratic Institutions, Santa Barbara, and since then Professor of Chemistry, University of California, San Diego.

Dr. Pauling has been visiting professor at major universities on three continents and has received honorary doctorates from 25 universities throughout the world. His contributions to chemistry and his discoveries in the field of medicine have been widely recognized both at home and abroad. He has received the Ghandi Peace Prize, the Grotius Medal for Contributions to International Law, and other peace, freedom, and humanitarian awards. The American Humanist Association chose him as Humanist of the Year in 1961. He is author or co-author of eight books, some 375 scientific papers, and about one hundred articles on social and political questions.

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Dr. Barnaby C. Keeney
National Endowment for the Humanities
Washington, D. C.

BARNABY C. KEENEY was born at Halfway, in eastern Oregon, but made a high-ranking professional and intellectual reputation in eastern United States. After graduating from the University of North Carolina and receiving a master's degree and doctorate at Harvard University, he rose through the ranks from assistant professor of history at Brown University in 1946 to become professor, then associate dean and dean of the Graduate School, then dean of the College, and finally, in 1955, president of Brown University. He left Brown in 1966 to become Chairman of the National Endowment for the Humanities and the National Council on the Humanities.

Dr. Keeney has had a distinguished and scholarly academic career. More than a dozen American colleges and universities have awarded him honorary degrees. He was a Guggenheim Fellow in 1945-46. He is author of *Judgment by Peers* and several articles on history, education, and other subjects.

Dr. Charles Frankel
Department of Philosophy
Columbia University

CHARLES FRANKEL, a member of the faculty of Columbia University since 1939, is currently editor-at-large for *Saturday Review.* He was born in New York City and educated at Columbia and Cornell universities. He received his Ph.D. degree from Columbia and has been a professor of philosophy at that university for 12 years.

A widely recognized educator and author, Dr. Frankel has many interests. He has served as Assistant Secretary of State for Education and Cultural Affairs (1965-67); planning director for the Vassar Institute for Advancement of College and University Teaching; host for the CBS TV program "The World of Ideas"; chief consulting editor for *Current* magazine (1960-65); member of board of directors of the New York Civil Liberties Union; and chairman of the committee on professional ethics for the American Association of University Professors (1956-59). He has been a Guggenheim Fellow, Fulbright Research Professor at the University of Paris, and Carnegie Corporation Reflective Year Fellow. He is author of a dozen books, the most recent of which, *Education and the Barricades,* was published in 1968.

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Dr. Philip Abelson
Geophysical Laboratory
Carnegie Institution of Washington

PHILIP ABELSON has been the distinguished editor, since 1962, of *Science,* the weekly publication of the American Association for the Advancement of Science. He has been associated since 1939 with the Carnegie Institution of Washington, except for five years when he was principal physicist for the Philadelphia Naval Research Laboratory. He has been director of the Geophysical Laboratory, Carnegie Institution of Washington for the past 15 years.

A native of Tacoma, Dr. Abelson is a graduate of Washington State University with a Ph.D. from University of California, Berkeley. In addition to his major doctoral work in nuclear physics, Dr. Abelson's areas of research and special knowledge include radiochemistry, biochemistry, physiology, microbiology, geochemistry, and paleobiochemistry. He has served numerous national organizations, including the National Research Council, National Institutes of Health, Atomic Energy Commission, National Cancer Institute, and the National Institute of Arthritis and Metabolic Diseases. Among his awards is the Navy Distinguished Civilian Service Medal.

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Dr. Edward E. David, Jr.
Bell Telephone Laboratories
Murray Hill, New Jersey

EDWARD E. DAVID, JR., in his 19th year with Bell Telephone Laboratories, is executive director of this firm's Research Communications Systems Division at Murray Hill, N. J. He has worked in underwater sound and communication accoustics and since 1963 has specialized in computing science research with particular emphasis on man-machine communications. He holds patents on inventions relating to underwater sound, sound localization, and speech processing.

Dr. David was born in Wilmington, North Carolina. He is a graduate of Georgia Institute of Technology and received master's and doctor of science degrees from Massachusetts Institute of Technology. He has received an award as one of nation's outstanding engineers from Eta Kappa Nu, national engineering society.

He is a member of the National Academy of Engineering and vice-chairman of the Commission on Engineering Education. He is a Fellow of the American Academy of Arts and Sciences, the Acoustical Society of America, the Institute of Electrical and Electronic Engineers, and the Audio Engineering Society. He also serves as professor of electrical engineering at Stevens Institute of Technology.

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Dr. Daniel G. Aldrich, Jr.
University of California
Irvine

DANIEL G. ALDRICH, JR. joined the University of California in 1943 as a junior chemist in the Citrus Experiment Station at Riverside. Since then he has moved upward through various research and administrative positions on four campuses in the vast University of California complex—and as University Dean of Agriculture with responsibilities for statewide agricultural teaching, research, and extension service activities. Since 1962 he has been Chancellor of the University of California, Irvine. He not only presided at the birth of the Irvine campus but has also nursed it along from bareground to opulence. He is also professor of soils and plant nutrition.

A native of New Hampshire, Dr. Aldrich graduated from the University of Rhode Island and received advanced degrees from the University of Arizona and the University of Wisconsin. His amazingly versatile personal, professional, educational, scientific, religious, sports, musical, youth, chamber-of-commence, and public-service activities are attested to by scores of memberships, offices, committee assignments and state and national honors, awards, and recognitions.

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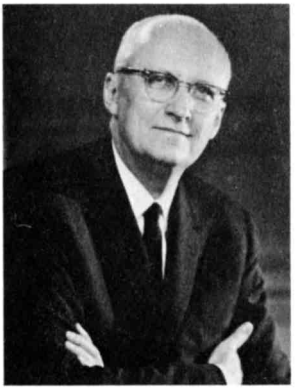

Dr. Fred Harvey Harrington
University of Wisconsin

FRED H. HARRINGTON, a native of New York State, was born at Watertown and received his early education in Albany and at Cornell University, where he received his A.B. degree with honors in history in 1933. He received his master's degree (1934) and Ph.D. degree from New York University (1937).

He taught history at New York University, University of Wisconsin, and University of Arkansas. As an administrator he has served at Wisconsin as chairman of the history department, special assistant to the president, vice president for academic affairs, vice president of the university, and since 1962 president of the university.

Dr. Harrington has been a member of advisory committees to the Secretary of State on foreign relations, to the Secretary of the Army on military history and ROTC, to the Peace Corps, and to the Air Force Academy. He has served in various ways on groups concerned with accrediting, industrial and educational research, educational testing, educational broadcasting, federal legislation, and state universities and land-grant colleges.

He is a member of Phi Beta Kappá, Phi Kappa Phi, and Phi Eta Sigma honor societies. Foreign travel and lecturing have taken him to western Europe, India, Indonesia, Korea, Japan, and Mexico. He is author, co-author, or consulting editor for a number of biographies, and books on history and American and foreign higher education.

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Dr. W. Robert Parks
Iowa State University

W. ROBERT PARKS was born in Lincoln County, Tennessee. In college and university he majored in political science and economics, receiving a B.A. degree from Berea College (1937), M.A. degree from the University of Kentucky (1937), and Ph.D. degree from the University of Wisconsin (1948).

From 1940 to 1948, except for three years in the U.S. Navy, Dr. Parks served in research and administrative capacities with the Bureau of Agricultural Economics in Washington, D. C. He joined the faculty of Iowa State University in 1948 as a professor of government. In 1956 he went to the University of Wisconsin as a professor of agricultural economics for two years and then returned to Iowa State as dean of instruction. He moved up to the office of vice president in 1961 and became president in 1965.

Dr. Parks is author of a book on soil conservation and contributor to other books and professional journals. He is a member of Phi Kappa Phi, Pi Sigma Alpha, and Pi Gamma Nu honor societies and of various professional associations.

At the universities of Kentucky and Wisconsin and Iowa State University and in government work, he has been closely associated with land-grant universities. He has also served as president of the Mid-American State Universities Association.

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The Role of the University

THE ADVANCEMENT OF KNOWLEDGE— ORTHOMOLECULAR PSYCHIATRY

Linus Pauling
University of California, San Diego

THE period of one hundred years since the founding of Oregon State University has seen tremendous changes in the world, far greater than during any preceding century. These changes have resulted almost entirely, directly or indirectly, from the discoveries made by scientists—from the advancement of knowledge. Many important discoveries were made before 1869, but many more have been made since that year.

We now have a far more penetrating understanding of the nature of the world than the people of earlier generations had. The fear of the unknown, of supernaturalism, that troubled people of former times no longer is a serious matter for the majority of human beings. The acceptance of a rational view of the world has constituted a great advance.

Despite the rapid progress that has been made, we recognize now that there remains a tremendous amount still to be discovered and understood and that there are tremendous opportunities for improvement in the world. I believe that the coming century will bring an advancement of knowledge even greater than that during the past century.

I shall talk today in part about how scientific discoveries are made, drawing from my own observations of other scientists over the last half century, and also from my own experience.

I came to Oregon State fifty one and one-half years ago, and soon learned some lessons about how to solve problems. During my first day in Corvallis, as I was walking across the campus, Pro-

fessor Charles Johnson of the Department of Mathematics spoke to me, asking if I were a new student. After we had talked a bit, he recommended that I register for sophomore mathematics, differential and integral calculus, during my freshman year, and he was my teacher in that subject. I remember puzzling over a difficult calculus problem as I walked about the campus later that year and finally seeing how the problem could be solved. I had another lesson, of a different sort, during my sophomore year. I was employed by the Chemistry Department to make solutions of different chemicals for use in the laboratories. When we needed some concentrated ammonium hydroxide solution I bubbled ammonia gas through distilled water in a large carboy. I had the problem of transferring the saturated solution to smaller bottles. The carboy was too heavy for me to lift, so I made a siphon by putting two glass tubes in a two-hole stopper in the carboy, one of them to allow the flow of the liquid and the other to permit me to blow into the carboy to develop enough pressure to start the siphon. After the siphon had started I opened my mouth, forgetting that the ammonia gas above the liquid in the carboy was under pressure and would blow back into my mouth. The ammonia caused some of the mucous membrane of my mouth to fall off. This experience taught me that one must not be satisfied with having solved one problem but must consider the possibility that the solution of the problem will lead to still others.

During the year 1919-20, between my sophomore and junior years, I spent a year as a full-time member of the chemistry staff. I was teaching assistant in quantitative analysis, with a desk in the small room that served as the chemistry library. I read the *Journal of the American Chemical Society* and some other scientific journals. I think that it was the experience of reading the papers in the *Journal of the American Chemical Society* that impressed upon me the idea that it is possible to learn something new about the world, something that no one else has ever known before, by investigating the world, by carrying on research. It was during this year that I became deeply interested in the problem of the nature of the chemical bond. I read the papers of Gilbert Newton Lewis and Irving Langmuir on the electronic structure of molecules, and I began making the effort to correlate the physical and chemical

properties of substances with their structure that has occupied me during most of the time since then.

There are many ways of making discoveries. Albert Tyler, who was Professor of Biology in the California Institute of Technology and who had worked for many years with Thomas Hunt Morgan, told me that Morgan had said to him that a little idea is all that is needed to permit a scientist to get started. Even a simple experiment, when carried out, may suggest another experiment, which may lead to another idea, until, as a result of a succession of ideas and experiments, a really significant discovery is made. Some discoveries are unexpected; an observant scientist notices that something unusual has happened. Many discoveries are made in a different way: by thinking about the world, thinking of something new, some new possibility, and then devising a way of testing it.

Thinking has sometimes been defined as the process of solving problems. It is probably much broader in scope. In much of our thinking we are groping to find out what the problems are, what needs to be done; not to find an answer to a problem. New ideas in science often involve the recognition that there is a problem, that a problem exists.

Different people look at the world in different ways. In 1936 Professor Karl Landsteiner, who had discovered the blood groups in 1900 and had been associated with the Rockefeller Institute for Medical Research in New York for a number of years, spoke to me after I had given a lecture about hemoglobin at the Institute. He asked me what my opinion was of some experimental results in the field of immunochemistry. I talked with Dr. Landsteiner about immunochemistry several times during the next three years, and I discovered that he and I looked at the world in quite different ways. When we were talking about the significance of the results of some immunochemical experiments, Dr. Landsteiner would ask, "What do these experiments force me to believe about the nature of the world?" and I would ask, "What is the most general and esthetically satisfying picture of the world as a whole that we can formulate that is not eliminated by these experimental results?"

There is a popular conception that scientists work by applying their powerful intellects in the straightforward, logical deduction

of new general principles from known facts and of conclusions from the general principles, and solve problems in this way. I am sure that this is done to some extent, but I believe that much scientific progress is the result of unconscious processes. The French mathematician Henri Poincare has described the way that he made a discovery about the nature of Fuchsian functions. He worked on these functions for some time and then went on a vacation, a trip to examine geological formations. As he was putting his foot on the step of a bus to go from one geological region to another, he suddenly thought, as his foot was raised onto the step, that the transformations that he had used to define these functions were identical with the transformations of noneuclidian geometry. This thought, which came suddenly into his conscious mind, led to significant new developments in mathematics. I think that his unconscious mind had been working away on the problem during the whole time.

A number of years ago I recognized that I had been making use of a related method to solve problems. I would work for some time, for several days or weeks at my desk, in an effort to solve a problem. Then I would lie in bed, night after night, and think about the problem in its various aspects before going to sleep. If no solution had been obtained I would then stop working on the problem. It would sometimes happen that the answer to the problem would suddenly occur to me, months or even years later. I think that I had trained my unconscious to keep this problem in mind and to connect it or attempt to connect it with every thing that was passing through my conscious mind, with every idea, hundreds or thousands every day. Finally there would seem to be a significant correlation, which would then be brought to the attention of my consciousness.

I shall give an example. About twenty years ago I became a member of the Scientific Advisory Board of Massachusetts General Hospital. One year at the annual meeting of the Board, Professor Henry K. Beecher of Harvard Medical School gave a talk about the work that he was doing on anesthesia. In the course of the talk he mentioned that the noble gas xenon is an effective anesthetic agent. That evening I mentioned to my wife and our eldest son, who was a medical student at Harvard Medical School, that it was

difficult to see how xenon could act as an anesthetic agent, because of its chemical inertness. They agreed with me that it was hard to explain this property of xenon. I thought about the problem for some time and then forgot about it. In 1948 I had participated in the Hixon Symposium on Cerebral Mechanisms that had been arranged by a former Oregon State student, Lloyd Alexander Jeffress, now Professor of Psychology in the University of Texas. In the course of this symposium I had learned about the evidence indicating that there are several cerebral mechanisms. First, there is the consciousness and ephemeral memory, which consists of some sort of electric oscillations in the brain; second, the permanent memory, consisting of a material (molecular) pattern in the brain; and third, the mechanism of interaction of these two. Some years later Dr. Richard Marsh and I determined the structure of crystals of chlorine hydrate, which had been discovered more than a century ago by Michael Faraday, and I learned that xenon and some other gases also form crystalline hydrates. Then one morning in April 1959, as I was sitting in my office in the California Institute of Technology reading my mail, I began to read a manuscript sent me by a friend in the University of Pittsburgh. He and one of his students had determined the structure of a crystalline hydrate of an alkyl ammonium chloride. As I was reading the paper I suddenly said to myself, "I understand anesthesia. I have in my head a molecular theory of general anesthesia. There are substances in the brain similar to the alkyl ammonium chloride—the electrically charged side chains of proteins and chloride ions. In the hydrate crystal that I have been reading about, which melts at 25°C, there are cavities that might be occupied by molecules of xenon or some other anesthetic agent. The van der Waals attraction of these molecules for the water molecules would further stabilize the crystals, so that they would exist at body temperature. These minute hydrate crystals would trap some of the electrically charged protein side chains and the ions to prevent them from moving and contributing to the electric oscillations in the brain that constitute the ephemeral memory and consciousness and, accordingly, unconsciousness (anesthesia) would result." This idea would require that a person would become anesthetized without an anesthetic agent if the temperature of the brain were decreased somewhat.

On reading the literature I found that this in fact does happen. I also found that there was a correlation between the anesthetic potency of different substances and the strength of their van der Waals interaction with water molecules, as shown by the stability of their crystalline hydrates. This microcrystal hydrate theory of general anesthesia was developed independently by Professor Stanley Miller, in La Jolla, at about the same time.

The development of the concept of molecular disease had a somewhat different history. As a result of my conversations with Dr. Karl Landsteiner I had begun some experimental work, with Professor Dan Campbell, Dr. David Pressman, and a number of students, on the nature of the forces operating between antibodies and antigens. This work provided strong support of the idea that the combining regions of an antibody molecule and its homologous antigen are complementary in structure. It seemed to me clear that biological specificity in general, including the specificity of action of genes, is based upon a detailed molecular complementariness. One evening in the spring of 1945, while I was having dinner with several physicians in New York, Professor William B. Castle of Harvard University, began talking about the disease sickle cell anemia, which is characterized by a change in shape of the red cells of the blood. I was not especially interested in what he was saying, because of my feeling that cells, containing perhaps thousands or tens of thousands of molecules of different kinds, were too complex for attack by the methods of structural chemistry. Then, however, he said that the cells are sickled (twisted out of shape) in the venous blood, and resume their normal shape in arterial blood. Within a few seconds the thought occurred to me that the principal difference between venous blood and arterial blood is that the hemoglobin is present as hemoglobin in venous bood and oxyhemoglobin in arterial blood; that the sickling must be related to the nature of the hemoglobin molecule; that if the hemoglobin molecules in the red cells of the patients with the disease differed from ordinary hemoglobin molecules in having two self-complementary regions on their surface they would aggregate into long rods, which would then attract one another to form long needle-like crystals, twisting the red cells out of shape and causing the manifestations of the disease; and that accordingly sickle

cell anemia could be described as a molecular disease, resulting from the presence of an abnormal form of hemoglobin in the red cells of the patients. My students and I began work on this problem, and in 1949 we published our paper "Sickle Cell Anemia, a Molecular Disease" (Drs. Harvey Itano, S. J. Singer, and I. C. Wells participated in this work.) There are now about one hundred abnormal human hemoglobins known, many of which are associated with manifestations of disease.

About fifteen years ago, after Dr. Itano had moved to the National Institutes of Health, my associates and I began work on mental disease in order to investigate the extent to which mental disease can be described as having a molecular basis. For some time we worked largely on mental retardation. Then, when I left the California Institute of Technology in 1964, the work was brought to an end. About a year later I found that some pieces of information that I had come in possession of had led me to think about the relation between substances such as the vitamins and mental illness. A study of the literature led me to write a paper, published in *Science* in 1968, with the title "Orthomolecular Psychiatry" and the subtitle "Varying Concentrations of Substances Normally Present in the Human Body May Control Mental Disease."

There is much evidence that the functioning of the brain is determined by the molecular structure of the brain. I have mentioned the anesthetic agents, which cause unconsciousness. Substances such as LSD, marijuana, and hashish affect the functioning of the brain, and may cause permanent damage.

In addition to these substances, there are many substances that are required for the proper functioning of the brain. Fifty years ago there were in the world hundreds of thousands of people who were psychotic because of pellagra. When these people were given a few milligrams of niacin per day (nicotinic acid, a form of vitamin B3) they recovered both from the mental manifestations and from the physical manifestations of the disease. Mental manifestations are also associated with scurvy, which results from a deficiency in vitamin C, and also from a deficiency in several other vitamins, of which I may mention pyridoxine, riboflavin, cyanocobalamin (B12), folic acid, and pantothenic acid. The last of these, pantothenic acid, was discovered by Professor Roger J. Williams,

who was in the University of Oregon and later in Oregon State University, before he went to the University of Texas. Only two years ago Professor Williams and one of his associates published an account of their investigation of the needs of guinea pigs for ascorbic acid. They reported that the amount of ascorbic acid required to keep a guinea pig in good health, free from scurvy, varies by a factor of 20 from one guinea pig to another in the sample of guinea pigs studied by them. They pointed out that human beings are probably more heterogeneous genetically than the guinea pigs they studied and that the needs of human beings for ascorbic acid might well vary by a still larger factor. I have been trying to find the evidence on which the Food and Nutrition Board of the National Research Council has based its recommendation of sixty milligrams of ascorbic acid per day for a 70-kilogram man. There is no doubt that a considerably smaller intake of ascorbic acid produces scurvy in the average person. The recommended amount probably is sufficient to prevent overt manifestations of the disease in most people. Little effort has been expended to determine the optimal intake of ascorbic acid, the amount that produces the most beneficial results. The biochemist Dr. Irwin Stone has estimated that three grams per day is close to optimal for the average person. It is my opinion that this amount, rather than sixty milligrams per day, is closer to the optimal intake.

Patients with pernicious anemia or with a deficiency of vitamin B12 for some other reason are observed often to suffer from psychosis for several years before any of the physical manifestations of the avitaminosis manifests themselves. In one study in Norway, fifteen percent of the mental patients admitted to a mental hospital over a period of one year were found to have a pathologically low level of vitamin B12 in the blood, less than 150 picograms per milliliter. The investigators stated that these patients were all given injections of the vitamin and that this led to improvement in their mental health. Similar evidence for some other vitamins, indicating improvement in mental health on ingestion of large amounts of the vitamins, exist in the literature.

There is no doubt that these substances, which are normally present in the brain and are required for proper functioning of the brain, have an influence on mental state of a person, and there is

the possibility that varying their concentrations can be of value in controlling mental disease in some patients. Many of these substances are nontoxic; ascorbic acid, niacin, and niacinamide are less toxic than sodium chloride and probably no more toxic than ordinary sugar. I believe that if varying the concentrations of these substances can be effective in controlling mental illness, this sort of therapy is far more desirable than the treatment of the patient with powerful drugs, such as chlorpromazine, or with electric shock therapy. I believe that physicians and medical research men should make a much more thorough study of this possibility than has been made in the past.

There is another aspect of nutrition that I may mention. About twenty percent of the American people, forty million of them, suffer from starvation or malnutrition. In some communities in the United States ninety percent of the children come to school without having had any breakfast. Hundreds of thousands of children are born each year in the United States with significantly decreased intelligence because of damage to the brain in the fetal state and in infancy and childhood because of malnutrition of the mother and the child. We, in this affluent country, have the duty to rectify this terrible condition.

About sixty percent of the people in the world, numbering about two billion, the poor people of the world, live on ten percent of the world's income. Their average income is $100 per year. Their total income, $200,000,000,000 per year, is equal to the amount of money wasted by the nations of the world on militarism. I mention this great injustice in order to point out that there are many problems that remain to be solved. I believe that, through the discoveries that have been made by scientists and that will be made by scientists, and through the development of a general feeling of moral responsibility for humanity as a whole, it will be possible for the world to be made a much better place during the coming century than it is now. Oregon State University is now contributing to the application of man's powers of reason to the problems of the world. I wish Oregon State University a happy future.

EDUCATION TO MEET A CHANGING SOCIETY

Barnaby C. Keeney
National Endowment for the Humanities

THE topic you have set me, "Education to Meet a Changing Society," is not a small one, and it could be interpreted a great many ways. I could talk, for example, about education as an agent of change. I could talk about it as a conservative force which slows down change by transmitting tradition. I could talk about it as a means by which people who are faced with change can better cope with it. I shall do none of these and all of them, but I shall concentrate on the university as seems appropriate on this occasion. First, however, I shall set a few points of reference. The first of these concerns the university.

One of the standard cliches about the university is that its functions are to preserve, transmit, and create knowledge. It is an archive, it is a teacher, and it is a creator. Thus, in the same place we have Mark Hopkins on the one end of the log and the student on the other and Clark Kerr's research factory. The log, of course, is hollow, and contains the archive.

Another cliche is that teaching and research are inseparable. Like many generalizations, this one is not true, but it is a very good defense against Government auditors when dealing with overhead.

We tend to forget that the university as a teacher is often a conservative force because it tends to pass on what is already known, sometimes without speculation about what is not known. Conservatives who support education do so because they feel that

it stabilizes society. Even though the teacher himself may be a radical, the knowledge that he makes available to his students is likely to be more persuasive than his rhetoric, and knowledge of what is or has been is likely to have a conservative influence. On the other hand, the university as a research center is a radical force, because much research tears up what we know by demonstrating it to be untrue or only partly true and replaces it with new knowledge and new ideas. At present, there is a great battle going on between those who would use education and research to preserve and gradually improve our society and those who would use it radically to alter and perhaps to destroy what is. This battle has not been resolved. The issue is well stated by Germaine Bree, writing about Satre and Camus.

> *In a sense, each in his way had come to reformulate two of the basic functions of the Humanities, that must be both "breakers of images" and "makers of images." But it seems essential too that, if our action is to be constructive, we must act as mediators, distinguishing between what it is necessary to destroy and those hard-won values which must be maintained."*[1]

The university, thus, is in tension between its conservative and radical functions, with the humanities as the mediator.

The second point is the American Revolution, whose 200th Anniversary we are now preparing to celebrate. The Revolution has special status among revolutions. It separated no king from his throne or his head. It disenfranchised no ruling class, excepting as its members chose to leave the country, and it carefully preserved most of the institutions of the regime which it overthrew. It did, however, effect a very fundamental change in the form of government. It established a republic, based on equality, liberty, and justice, which had been the aspiration of political philosophers for 100 years and more, and it set forth certain goals that have been the inspiration of political and social reformers and revolutionaries throughout the world ever since. Some tend to think of the Revolution as legitimizing conservatism in this country, partly

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[1] Germaine Bree, "Humanities and the Human Condition," *The Record,* Teachers College, Columbia University, Vol. 70, No. 3, December 1968, pp. 183-189.

because it was a very conservative revolution and partly because we have canonized it. The American Revolution is a holy thing to us, and anyone who revolts against it is a traitor. And yet, at the same time that the American Revolution legitimized conservatism, it also legitimized revolution, simply because at the beginning of our history there does stand this sacred revolution and even though in our fundamental document revolution is made illegal, the very fact that there once was one reminds people that there might be another. So, as we have in our universities a tension between conservatism and radicalism, we have in our whole society a tension between conservatism and revolution.

The eloquent and elegant statement of Julian Boyd puts this better and differently, pointing to the Revolution's radical aspects:

> *It became in fact, a world power at the instant of birth by virtue of its proclaimed purpose of creating a society based on the concept of the equality of man and governed by reason and justice. It was the most radical and irreversible revolution of history because its moral proposition included the transfer of sovereignty from the hereditary ruler to the individual citizen.*[2]

My third point is the bases of society. Sometimes they are called the Ten Commandments. Sometimes they are called goals, consensus, obligations, values, aims, myths. I prefer to call them assumptions. They are, in fact, all of these things. They are commandments in that they have the sanction, either of the divine or a secular power. They are obligations in that they are the necessary duties of individuals and groups to each other and to their society. They are goals or aims in that they are never fully achieved, and they are myths in that they are sanctified by the past, assumed to be true and repeated without proof.[3] They are assumptions in that they are stated, but seldom carefully examined. I have read that

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[2] Julian P. Boyd, "Between the Spur and the Bridle," The Association of American University Presses, 1968.

[3] Dr. Rollo May, *The New York Times*, p. 49, November 25, 1968.
See also John G. Kirk, ed., *America Now*, Atheneum, New York, 1968, *passim.*

one cannot create a myth and yet the authors of the Declaration and the Constitution very effectively created the myth that all men are created free and equal, and they have had the enthusiastic support of six generations of Americans since. They know when they uttered these inspiring words that in truth men were neither free nor equal and only in the most metaphysical sense can they be regarded as created equal. For almost 200 years we Americans, who proclaimed our belief, both in the virtue and in the existence of freedom and equality, have passed and enforced laws preventing the fulfillment of either.

Now the significant thing about America today is that our assumptions are no longer assumed. Our myths are no longer believed. Our goals no longer stand out as a beacon for our conduct, as individuals or as a country. The reasons that our assumptions are no longer assumed are very simply that enough of them have been proved to be untrue or incompletely true, that an increasing number of our people have moved to a new assumption, namely, that none of them are true. The real tragedy of Lyndon Johnson is that he attempted to govern on the basis of consensus at the very time when the consensus broke.

The second significant aspect of our society is that its legitimacy is challenged by a significant part of our population. On the left, this is called the new politics. On the right, it is called George Wallace or the John Birch Society. Both challenge the legitimacy of our society for the same reason, namely that while it has achieved, or nearly achieved, most of its goals, it has not agreed on new ones. Moreover, it has not perfectly achieved any of them. This displeases the radical because it leaves him no legitimate line for further change, excepting in detail. It displeases the reactionary because it makes it impossible for him to praise equality while denying it.[4]

These are my three themes: tradition and change in the university, conservatism and revolution in our political society, and the death of our assumptions, together with the denial of the legitimacy of the basic structure of our society.

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[4] Irving Kristol, "The Old Politics, the New Politics, the *New,* New Politics," The *New York Times Magazine,* November 24, 1968, Section 6.

Now let us look in a little more detail at some of these, and finally see what education can do about it.

First, the university, The American university has three parents who have the further peculiarity of belonging to three definite periods. The classical liberal arts college was imported into this country from England. Until recently, it was a comfortable, conservative, and sometimes elegant institution, dedicated to preparing and perpetuating the ruling class of lay and clerical leaders and admitting its new members. The liberal arts college sired the university as a teacher. The land grant college was created 100 years ago as a radical effort to introduce into education serious consideration of practical industry and agriculture and to apply knowledge to these businesses which were the business of America. The land-grant college was dedicated to change in the material sphere, but not to change in the social and political spheres.

On top of the conservative liberal arts college, and then on top of the land-grant college was placed the German university, which well represents the archival nature of the university, for it was dedicated to knowledge for its own sake, unapplied. The result of these curious graftings has been the construction of the peculiarly American university, which whatever its origins, teaches in the sense of the undergraduate liberal arts college, seeks useful knowledge as the land-grant university, and seeks knowledge for its own sake as the German university. Much of the material change in our society has resulted from the research done in universities, but unfortunately the research that has been effective in producing change has been for the most part in science and technology, where application comes readily to mind and is reinforced by the land grant tradition.

These changes have been important, significant, and mostly beneficial, but they have not been accompanied by the application of humane knowledge and rather little by the application of social knowledge. Nevertheless, in all living universities today, and some of them are not alive, the habit of questioning and investigation is encouraged, which has resulted in the challenging of many of our ideas and institutions without the creation of adequate new ones. Just as there is a tension in the university between tradition and change, there is a tension between knowledge for its

own sake and knowledge for application. Whatever the field, the beginning student is apt to try to apply his knowledge. In the applied fields, he is encouraged. In the pure fields he may be repressed.

Let me quickly and superficially mention some of the enormous changes that have been brought about by research conducted in universities. Millions of people would be dead today had not Fleming rediscovered and applied penicillin at Rutgers; had Goddard not been at Clark, we might not be looping around the moon; and but for Galileo's researches, the Christian view of the universe, which in itself is not very encouraging to space flights, might still be unchallenged. The land-grant colleges helped produce the hybrid corn that has not only changed our habits of life but also has made Mexico a relatively stable and prosperous society. But for university scientists, we could all be born without intervention of the pill and confidently expect to die when our hearts give out. We would not have to worry, on the one hand, about a nuclear holocaust nor dream about the benefits of cheap atomic power.

Note that none of these examples that I have hastily cited is in the humanities or in the social sciences. I can find a couple in the social sciences. One is the controlled economy, or rather the assumption that the economy can be controlled. Another is aspiration toward population control. Both of these, however, are aspirations, and not facts. Think as I will, however, I cannot find an example from the humanities, or from the arts, and this is a great disappointment to me for obvious reasons.

Why is this so? Partly, I think, it is because of the attiude of humanists toward their knowledge, which they think of as existing for its own sake, and only recently have begun to try to apply. Partly, I think, it is because of the attitude of society that humanistic knowledge is elegant, interesting, stimulating, and useless, or at least not very important in the business of America, which is business.

Remember when I speak of application, that almost all of the great effects of science on technology resulted from what was initially pure research. The men who discovered the principles of the atomic bomb were not trying to blow up Nagasaki. They were

trying to understand the structure of the atom and to manipulate it. Some of them, of course, became involved in the effort to apply the knowledge they had discovered, but this was a separate act, and not all of the appliers were involved in the fundamental discoveries. The historian who studies Southeast Asia does so to learn more about Southeast Asia. He may in time become interested in the application of what he has learned to contemporary problems, but if he does, this would be a separate act in most cases, and most of the application would be carried out again by others.

And yet research in the humanities has had an effect, a more subtle effect, and one that is less easy to identify. Again, it results from the tension between the teacher and the knowledge on the one hand, and the student on the other. Whether the scholar who is teaching the American Revolution looks upon it as an exercise in marching troops up and down hills and through swamps, or whether he looks at it as a set of ideas and aspirations found in documents and exemplified in events, he looks at it as the American Revolution.

The naive student, however, who is not yet a scholar, is apt to ask "What does it mean for me? What about this equality stuff—what does it really mean?" He may even go so far as to say, "Are these assumptions true, and if so, prove them." He may be so unscholarly as to carry the revolution into the present and ask, "Are these goals realized, and if not, why not? And if so, what do we do next, because our society is not perfect?" And then, increasingly in the last few years he may ask, "Will this be the final revolution, and should it be?" That is the nub of the question in American history. All of you who have studied and all of you who have taught know the tension that questions like these produce in the ordinary classroom.

Or let us look at a more peaceful subject—a less controversial one. Let us observe the professor of Latin, teaching Virgil to students who should have studied it in high school but didn't. I have seen in the same department in the same university, three simultaneous undergraduate courses in Virgil's *Aeneid.* One of them was a course in how to read Latin, or at least in how to read Virgil. The ablative absolute was the most significant idea encountered, excepting for occasional references by the professor to his long

lost youth. In the second course Virgil was taught as literature, and both forms and ideas were considered, but mostly literary style. In the third, however, Virgil was taught as a set of ideas and a set of situations facing individuals.

This latter course was characterized by fervent discussions among the students with the professor on what Virgil meant, what Aeneas was, and what they were. They learned a great deal about themselves, about mankind, some of them even thought out their own personal decisions for a year or so, and incidentally they learned a lot of Latin. Here the tension between knowledge and the teacher on the one hand, and the student on the other, was resolved, and in a very elementary course the students had an important intellectual experience.

Finally, my third point. What are the assumptions, and what became of them? I have already spoken of freedom and equality. Throughout most of our history the myth obscured the fact and ninety percent of the population lived comfortably at peace with their consciences, but the myth was finally destroyed in the last decade, and even though we have moved more toward freedom and equality since 1954 than we have in our whole previous history, we are still so far from achieving it materially, politically, and intellectually that our daily lives and our consciences are in constant turmoil.

Another myth is that of Horatio Alger. Everyone has an equal chance virtuously to attain the highest Horatian good in life, great wealth, yet everyone knows that it makes quite a lot of difference where you start if you set out to try, and where you happen to be when an opportunity arises. Though it is still true that many, and indeed more people, attain great wealth, it is no longer assumed that everyone has an equal chance and many of our brightest people do not want it.

A more fundamental assumption is that one must obey the law. In the 11th century Pope Gregory VII, in his effort to clean up the church which was thoroughly corrupt then, encouraged laymen to disobey the law as stated by their priests, if they judged their priests to be improperly ordained, or evil in their lives. This reformed the church, all right, but it greatly weakened its law, and it greatly weakened the unquestioning obedience that had hitherto

been given to clerics. Again, in the 1960's of this century, clergymen in particular and liberals in general encouraged the southern Negro to disobey the laws which they quite properly judged to be unjust. This produced great social and political advantages in the country, but again it weakened the law, and now an increasing number of our population, often for the most virtuous of motives, systematically disobey laws which they regard as unjust or tending to achieve an unjust end, and the very structure of our society is badly shaken. We have almost forgotten that there is a great difference between changing a law by action of the constitutional agencies of society, and destroying it by the actions of individuals whose consciences tell them they must disobey it. We have also forgotten the difference between disobeying a law to get it tested in court, and wholesale disobedience.

Another of our assumptions is that work is virtuous and that one should work hard and long, whether he needs to or not. The machine and automation have changed this a great deal.

I could go on a long time through a long list of assumptions that are no longer accepted. Some of them relate to sex. Some of them relate to what one does with his body and his mind. All of them are interesting and of fundamental importance. Partly, as a result of the weakening of our assumptions, and partly as a cause, there have been great changes in the family which is no longer an authoritarian institution, in the church whose dogmas are no longer unquestioningly accepted, and of course in the university and in the school which have inherited, unprepared, the moral and normative functions of the family and the church.

Now, finally I come to what I am supposed to talk about, which I interpret as the task of the university in the next generation. Like our political society, the university is under severe attack today and perhaps for the same reason, namely, that we have accomplished much of what we have set out to do in this generation, that we have done so imperfectly, and while we have been doing so, we have said a lot of things that simply are not true. For example, we have earnestly declared that full equality of opportunity in universities exists for everyone, regardless of his economic circumstances, his race, or his religion. This has never been true. When it was least true the assertion was not attacked. Now that it is

nearly true, not only the assertion but the university itself is locked in mortal combat with the seekers of perfection, and yet the university today does provide a more nearly equal opportunity with the help of the federal government than it ever has. It provides better resources for education with the help of the federal government. It has, in fact, nearly achieved what this generation of educators set out to achieve, and one of the causes of the discontent is that there are no great goals set out for the future, except to perfect what has been well begun.

In another sense the university has failed. It has stored great quantities of knowledge, more than have ever been stored before. It teaches more people and despite its faults, it teaches them better. It has created enormous quantities of knowledge; and it has taught us to apply part of this knowledge, but it is in the application that the failure has come. Of the great branches of knowledge, the sciences, the social sciences, and the humanities, the sciences are applied, sometimes almost as soon as they are learned. Strenuous and occasionally successful efforts are being made to apply the social sciences, but almost never are the humanities well applied. We do not use history in our public and private decisions. We do not use philosophy in defining our conduct. We do not use literature as a source of real and vicarious experience to save us the trouble of living every life again in our own.

The great tasks of the university in the next generation are to search the past to form the future, to begin an earnest search for a new and relevant set of values, which now I should rather call values than assumptions, and finally to learn how to use all the knowledge we have for all the questions that come before us.

I have some suggestions.

We tend to forget that the purpose of an undergraduate curriculum is to provide undergraduates with an opportunity to educate themselves. This does not necessarily mean recruiting more Ph.D. candidates in Middle-English literature, nor does it mean providing Ph.D. candidates with opportunities to support themselves in a marginal way as teaching assistants, nor does it mean an opportunity for a professor to lecture. It means providing undergraduates with an opportunity to learn about and to think about first-rate problems that are going to be important to them after they

leave college, at least for a little while, and to form the habits of learning and thinking so that they can deal with the problems that come up later on. In the professional schools, of course, they must also be provided with elementary training in their professions, training which is generally obsolete by the time they complete it and always within a decade unless the profession is a static one. In the humanities and in the social sciences, it is far more important that they learn to learn and learn to think about what they have learned, so that they can approach the world with the rationality upon which our society, and indeed our whole world, and our whole tradition depends for its successful operation.

Students today are so perfectly well aware of this that in very recent years they have turned more and more from trivia or incidental things or complaining about the lot of youth to some of the really important problems that face us today and probably will face us a decade from now.

Let me quote from the report of a very perceptive committee of trustees of another university. They first discuss the change from complaint about regulations on conduct to the generation gap to their principal concern—the interaction between the university and society. "They say that their disillusionment stems from a society which permits a racial imbalance and which tolerates a meaningless and an endless involvement in Vietnam; they say they are frustrated because their hopes for a better world which were kindled by the McCarthy victory in New Hampshire were later dimmed by the Nixon-Agnew victory in Miami and then brutally snuffed out in Chicago by Mayor Daley and with the nomination of Hubert Humphrey."

Today they demand to participate in all aspects of the governance of institutions. Students whose concerns as wide as those described—are not going to be completely satisfied with a routine standard presentation of traditional humanistic knowledge without any reference to the affairs of the day.

In that same university, the director of athletics, who conducts a remarkably fine intramural athletic program, defines the aims of the program as "to provide happiness for members of the student body and of the college community through purposeful activities." There is, to my mind, a certain disparity between the recognition of

student aspirations as defined by the Corporation and the perfectly worthwhile search for euphoria on the playing fields, which in another day and in another place was called strength through joy. Here, however, we have joy through strength. Joy, I might say, is not a characteristic of the present younger generation, and I can not recall a great deal of it in my youth, when Joe E. Lewis said, "You are only young once, and if you do it right, you never need to again."

I am not one of those who would turn over control of the educational program to the students, but I do earnestly believe that a good deal of what they say about their education makes sense and should be listened to and thought about, and sometimes acted upon. For one thing, I have never been impressed by efforts to educate people without involving them in their own education. For another thing, when a large percentage of our undergraduate population is clamoring to seek education for a purpose rather than for a degree, we ought to take advantage of the opportunity. Nor, on the other hand, would I think the whole focus of education should be entirely contemporary, since few problems can be understood without reference to their history and we are not born whole with the intellectual resources to marshal the past for the improvement of the present. Moreover, if one teaches entirely in the contemporary framework, many of the problems will have been solved within a reasonable time after the student studies them, and most of the methods used today will be obsolete, just as they become in science and technology. I would, however, relate what the students are studying, or rather let them relate it, to what they want to do, even though I know very well that ten years from now most students will not be doing what they want to do today, and will not even want to.

The conventional pre-medical curriculum, for example, is regarded both by students and faculty as one of the dullest exercises that can be conducted. This is not because the subjects are necessarily dull but because the student is taking the pre-medical curriculum because he wants to study medicine and then become a doctor, and he does not yet quite see why physics or even biophysics is relevant to this. He certainly does not see how the structure of society is of any importance. What a difference there is

when this same student, with roughly these same courses, spends an hour or two a week in a seminar with a succession of physicians and medical scientists, who before his eyes apply the knowledge that he is studying as a freshman or a sophomore to actual medical problems.

What I propose is really quite simple. I would take about a fourth of the student's time throughout his undergraduate years and organize it into courses which I would call history, and literature, and philosophy, and anything else that seemed appropriate and organize these courses around first-rate problems. The differences between first-rate human problems and second- and third-rate ones is that they tend to be around for a long time, whereas second-rate ones tend to get solved and become of antiquarian interest. For example, when our ancestors came here, they had the problem of how to get the Indians out of the way. This was a second-rate problem to them, though not to the Indians, and they solved it quickly and expediently by knocking off most of them and putting the rest of them on the reservations, from which they removed them if the lands became desirable. The first-rate problem of human justice, however, is still with us and we have not resolved the lingering results of the expedient solution of the second-rate problem.

It would take a great deal of skill and sophistication to identify the first-rate problems, and probably they would have to be approached through preliminary examination of a series of second-rate problems. I would suggest that the students might be better at identifying the problems initially than the faculty, and the faculty than the students at distilling a collection of transient problems into the real issues. I touched on one body of great problems that faces us related to work and leisure—leisure in the sense of constructive use of one's mind and other resources in the time he does not need to produce the material necessities of life and to defend himself. In this sense, research is a leisure activity, whereas going to the ball game is play.

Work and leisure involve our whole ethical system. It was a central question in ancient society, when work was regarded as the province of the lower classes and leisure of the upper. This attitude was revised in the monastic movement, when manual

work was raised to equality with prayer and study. Thus, dumb people could be holy, and the wise humble by working together in the fields and vineyards. In the Protestant period, work and the consequent wealth were regarded as evidence of virtue, an attitude that is still with us. Now, the effects of science, and particularly technology, have made it unnecessary for everyone to work all the time to produce the necessities of life, and in order to use up all our surplus energy, we have on the one hand taken to producing a lot of goods and services we do not really need, like enough bombs to destroy the Russians seven times, and on the other, have taken to aimless play, which I personally very much enjoy.

A constructive use of leisure is manifested in the enormous growth of education and research, for after a certain point both education and research are leisure activities from the point of society, though not of the participant. You are here because you are not needed in the fields and shops and armies. On the other hand, technological advancement has made it difficult, if not impossible, for about three percent of our wage earners to work at all, since they do not have the mental and educational resources to do so. Work and leisure are first-rate problems today, and they will be greater problems a decade from now.

Another first-rate problem is that of interfering with what some call human destiny, and others call biological development of the human individual, which is partly the result of genetic circumstances and partly the result of accidental environmental conditions. Throughout its history, that part of the population which has dedicated itself to the medical arts has systematically sought to interfere with human destiny by lengthening life and done so with the enthusiastic support of most of the population. Others, of course, have dedicated themselves to shortening human life, through crime and war.

Now it is anticipated that the next generation, and perhaps this one, will be able to interfere chemically with the actual development of an individual and perhaps biologically by interfering with his genes. We have a long history of speculation going back to antiquity on the consequences. There are first-rate ethical, moral, and philosophical implications to interfering with human development. Obviously, there would be benefits both to individ-

uals and to society from eliminating, or at least improving, mentally and physically deformed persons. On the other hand, there could be very serious consequences if this knowledge were used with premeditation to produce superior and subordinate classes, each genetically prepared to carry out a predetermined mission. Both Aldous Huxley and I suspect that this can be done. What happens then to free will, to democracy, and to the rights of the individual? Human destiny is a first-rate scientific, philosophical, and moral problem today. It will still be a first-rate problem when all of us are dead.

Now I shall list but not examine some other obvious examples. Can we be excellent and equal, too? What is an appropriate concept of virtue for contemporary society, with all the social, scientific, and technological changes that have occurred? What are appropriate forms of organization of human living today? Is the city obsolete? All of these involve many of the humanities and the social sciences. All of them could be taught with reference to specific knowledge and evidence. They could also be taught, of course, through idle speculation—through bull sessions in which students and professors stated their preconceptions and argued on the basis of conclusion rather than evidence, and I am sure some of them would be. I am also sure that in all of them there would be a tendency to do so, and in overcoming it, students would learn that the reiteration of a conclusion without the examination of evidence is not an effective way either to reason or to contend. They would have to learn a great deal in order to examine these questions with any degree of adequacy. I am quite sure that they would not complete the syllabus for History 101 as it currently is written, but in the course of four years they would learn a great deal of history, and above all, they would learn what it means.

Does there exist a whole curriculum for this? If there does, I do not know it. I do know of a considerable number of rather successful efforts to do just this in isolated parts of scattered colleges and universities and a few in whole colleges. Many of the colleges today are seeking ways like this to experiment. Some of them do it by taking students for field trips into urban slums, which is interesting, but is really dabbling. Others are developing curricula which fill the mind even more than it is now with undigested mate-

rial. Others are inspiring students to seek their own knowledge and their own education. There are, however, a few systematic efforts to bring fundamental knowledge and thought to bear upon the problems that will always be with us because they are first rate.

It would be very difficult to do. For one thing, our traditional preparation of faculty, that is, the Ph.D., does not lead in the direction of so global an approach, and those professors who can do it, do it as a result of their subsequent self-education, of which such a program could be an extremely important part. Probably if we do decide to do what I have suggested, we should revise the Ph.D. program, perhaps by replacing the meaningless final examination with another exercise in which the student who has satisfied all other requirements be required to select an important contemporary question, and write an essay on it, bringing everything relevant that he can think of in his field to bear upon the question.

Even given a qualified faculty, such courses would be extremely difficult to teach. There would always be the danger of superficiality, of repetition, of domination by aggressive students or professors. Finally, the traditional members of the faculty would say, "But the students won't learn enough to go to graduate school." Certainly they would not learn everything that we are in the habit of making them learn, but they would learn some things that we are not. I think that one could assume that in the other three-quarters of their time, they would learn what they usually do, and they might even learn to think about it by carrying new habits into their more conventional courses.

I believe the advantages would be overwhelmingly greater than the disadvantages. The purpose of education, after all, is not only to impart knowledge—this is simply a step upon the way—but to teach students to use knowledge which they either have or will find, to teach them to ask and seek answers for important questions, and in short, to live rationally, as our founding fathers assumed that we would. A generation of men and women in the habit of thinking and behaving thus would direct serious questions to our disappearing assumptions and our values, and would perhaps produce appropriate norms for present and future conduct.

In the same way they would develop new goals for themselves and for our society. They would quickly find new areas in which

constructive innovation is necessary and possible. They would not become obsolete intellectually and educationally, as we quickly do now, but would constantly seek and find new areas for investigation. They would, of necessity, form the habit of using all parts of our knowledge to deal with all of our first-rate questions. The present mood of destructive criticism would be coupled with a constructive and creative effort, which is really what the world needs today. The tensions of the dichotomies I stated at the beginning—between revolutionary and conservative education, assumption and fact, revolution and conservatism, would, for the moment at least, resolve these all into a newly creative America.

Man and His Environment

THE FUTURE OF POLITICAL THOUGHT AND POLITICAL INSTITUTIONS

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THE celebration of the centennial of a land-grant college which has grown and flourished and become a university is a peculiarly appropriate occasion for discussing the future of political thought and political institutions in this country, and, indeed, in the world. The land-grant college was a crucial part of the political scheme and the political institutions that governed the settling of this continent. It expressed the conviction that useful knowledge, systematically deployed, was essential to economic vigor, that democratic access to education was indispensable to political health, and that institutions of higher learning could serve as organizing centers for the development of civic loyalties and for the mounting of cooperative attacks on common problems.

The land-grant idea has more than made its way. The contemporary university has become the linchpin of any sophisticated and complex form of social organization. In modern societies, it is the major center of innovation, intellectual, technical, or moral, the major center of systematic social inquiry and social criticism, and the major instrument for making equality of opportunity a reality. It is the one institution above all to which we must look if we wish, in an era of breakneck social change, to keep perspective, to use the human heritage intelligently, or to move into the future with even a modicum of rational appreciation of the nature of the choices we are making.

In a discourse on the future of political thought and political institutions, it is only fair that one state one's bias at the very beginning. My own is that political ideas and institutions should be tested by their consequences for the strength and character of institutions of higher education. This is not the only test of political ideas and institutions, but it is an essential one, and it is in the background of much that I shall say in these remarks. To talk or to act in the field of politics and social change without taking into account the impact of what one thinks and does on education and learning is like prescribing remedies for a patient without considering what effect they will have on his eyes or brain.

It is difficult to look ahead to the future these days; the present is so ominous as to make such speculations seem like a luxury. Indeed, there are those who argue that the present, in all its weight and wickedness, is quite enough to occupy us, and that the time to think about the future is after we have brought the present to a full stop. Others of us, however, are still inclined to believe that acting first and thinking about the consequences afterwards has been mankind's classic road to disaster. For those of us who hold this view, reflection on the future is an essential condition for responsible action in the present.

How, then, shall we think about the future of our political institutions? There are, I think, four general ways of thinking about the future that are in the air these days. Of the first we need say very little; it consists simply in projecting a world, fifty or a hundred years from now, which is not changed very much from the present except on its technological surface. We shall have new gadgets; we shall be able to produce more, travel faster, deal with disease even more efficiently. But the world will still be perched on the brink of terror; social conflict will be as severe as it is now; man's relation to his natural environment will still be out of control; and professors will still be attending conferences to talk about the future. Of this view it is enough to say, I think that its apparent pessimism hides a deeper optimism. It assumes that our civilization can go on as it has been going on. I think this highly doubtful. We shall either do better or we shall break apart into violent discord, tyranny, and war.

The second point of view is harder to assess. I would describe it as evolutionary and reformist. It does not look upon the political institutions that now exist as the final expression of human wisdom, but it assumes that by a series of corrective measures, by an accumulation of reforms, what is wrong with these institutions can gradually be set right. And it thinks of these reforms essentially as continuations of those which, during the last three decades, have eliminated or reduced some of the worst abuses of our society.

The future, in other words, will be simply a better present—a present that works. We shall have better welfare programs, more adequate housing, more efficient transportation, tougher laws to protect consumers, stronger safeguards against the pollution of the air and the water. We shall have more education for more people. We shall have political parties that have reformed their procedures of self-government and become more responsive to the electorate. We shall have learned, very probably, how to join price stability to steadily rising incomes. And as all these social improvements take hold, the tempers of people will improve, racial and other animosities will recede, and the country will have returned to the high road of equal rights and growing social harmony on which it thought it was moving twenty years ago.

Although the fashion has arisen of dismissing this point of view as superficial and evasive, I do not think these criticisms are fair. It proposes neither a retreat from battle nor a procession of merely token reforms. Each of the measures I have listed will require a struggle before it is accomplished—a struggle a great deal more wearing, and requiring a great deal more courage, day by day, than any of the struggles, demonstrations, manifestos, or confrontations which the protagonists of apocalyptic politics seem to think are real and serious politics. And if these reforms are achieved, they will represent a significant improvement in American life. Moreover, it can also be said in favor of this approach to the future that it probably expresses the hope of the broad middle sector of American citizens (and, I suspect, of the middle sector of citizens in most other advanced societies). Insofar as this is true, it has an element of solid realism about it. Prophecies in political affairs have a tendency to be self-fulfilling. If this view of the future is held by large numbers of Americans, and continues to be

held, it has some momentum on its side. My own belief, for what it may be worth, is that this evolutionary and reformist approach will be part of any viable political philosophy for the future.

But it can only be, I think, a part of such a philosophy. Taken by itself, it has a number of inadequacies.

In the first place, it assumes, as I have said, the essential continuity of our problems as we move into the future. Our solutions will change and get better, but the problems themselves will remain, on the whole, the problems we first learned to recognize thirty-five years ago in the days of the New Deal. That assumption needs only to be stated, I think, to be seen as mistaken. Technological changes from the computer to the birth-control pill, and from atomic energy to LSD, have already changed the character of social problems in our society; and if we can be sure of anything it is that the technological changes in store for us in the next fifty years will come even more quickly, and will dwarf in significance those that have occurred so far.

This is likely to be particularly true in the fields of biology and communications. Individuals and organized society are going to be faced by moral choices quite unlike any that people have had before. On the one hand they will probably be able to affect the genetic heritage of man, on the other hand they will be able to move and communicate with such speed and impact as to make existing national frontiers even more anachronistic than they are now. The liberties to be allowed to individuals in such a state of affairs are bound to require re-examination, support or modification; the power of the existing system of national sovereignty to provide an effective structure for the governance of mankind is bound to be challenged even more profoundly than at present.

In addition to the process of cumulative reform, therefore, we have to look for ways to produce basic structural changes in our methods of achieving reform. The speed and revolutionary impact of technological change has put our mechanisms for political adaptation under immense and dangerous pressure. Quite simply, they are much too slow. Even when they respond, they often respond so late that the problem that called for action has turned into something else. We come up with a remedy for the flu when the ailment we are treating has changed, by virtue of neglect, into

pneumonia. To maintain the possibility of peaceful evolution and gradual improvement through an accretion of reforms, political changes will be necessary, I believe, which will be regarded by those affected by them as equivalent to expropriation.

The elimination of the filibuster in the Senate or the removal of the seniority system for choosing committee chairmen in the Congress are relatively minor changes, compared to some of those that are needed. Yet even these would almost certainly arouse much opposition. Yet they are probably the minimal reforms needed if our deliberative bodies are to make decisions at the tempo which an era of accelerated change requires. To a considerable extent, our instrumentalities of government are still geared to the proposition that it is better not to act at all than to act quickly. That proposition made more sense in another kind of era than the one in which we live and shall live. Our political system's tardiness in responding to problems has already greatly undermined the faith that citizens repose in it.

Another reason why we cannot think that the future will be simply an improved present, descended in a straight line from the reforms that have preoccupied us over the last thirty years, is that these reforms have become part of the problem to be solved. Although they have accomplished much, they have created conditions which now cannot be rectified by prescribing still more of the same remedies that have produced them. Welfare programs are necessary, but more welfare programs cannot be regarded as a solution to hardcore poverty or to the desperate condition of our cities. Strong and decisive action by the federal government is required to meet our crises in education, transportation, or the conservation of natural resources, but a still larger federal bureaucracy merely threatens to aggravate the condition of apoplexy at the center and anemia at the extremities from which we are presently suffering.

Indeed, the old remedies were responses to complaints that were different in character and emotional tone from the complaints that have now made our system so unsettled. New social values have emerged—which is to say, that in response to the pains they feel, people have developed new demands, or have altered the priorities among their demands. What now seems to be increas-

ingly at issue and what is likely to be the issue even more in the future is not the condition of life of each of us viewed in isolation, not our pay envelopes or our chance to buy a home or our security against old age or unemployment, but rather the condition of our shared environment and the character of our communal life.

This new kind of issue shows itself in dozens of ways. It is revealed in the current grievances of people on both the right and left. On one side, people complain about danger in the streets, or about crime, pornography, drugs, and declining moral standards, or about styles in clothes and deportment designed to show contempt for established patterns of conduct. The desire for "law and order" is a desire for a general change in the character of the environment, and not simply for a change in the individual's own special situation. It is a left-handed, or perhaps a right-handed way of saying that there has been a decline in community. And on the other side, the American racial problem too has taken on this new dimension. The grievances of militant blacks are not now grievances, in the main, against acts of individual prejudice or overt discrimination. They are grievances against "institutional racism," against, for example, the character of the general culture of colleges and universities, which, it is held, is implicitly oppressive.

One need not agree with all or any of these complaints to recognize that the old politics, which focused on the improvement of the communal life by the improvement of the condition of individuals, has come under pressure from a new kind of politics, which focuses on improvement of the individual's condition by improving his communal life. And behind all this there exists an even deeper feeling: that the existing industrial environment, in its general impact and not simply in its specific inequities, is an untenable environment. The evolutionary, reformist approach, taken by itself, will not work because the problems we now confront are problems caused by a change in moral perspective. They cannot be solved without a marked shift of our political sights.

Reforms along the old path will not remove the growing and increasingly restive sentiment that we are wasting our wealth and wasting our days on meretricious and frivolous pursuits. We can send men around the moon, but millions cannot get home from work without unconscionable delays, crowding, and wear and tear

on their bodies and spirits. We can send pictures through the air, and what we have chosen to do with this remarkable power is to use it to sell cigarettes. While the great majority of us worry about eating too much, we still have people dying of malnutrition. While we spill blood and treasure abroad to defend ourselves against an alleged conspiracy against our freedom, we find ourselves at home turning in desperation to the police to protect us against disorder. And while we can build machines that produce prodigious feats of calculation for us, we have no system of social cost-accounting that responds to our everyday sense of what counts. When we tot up the increases in our Gross National Product, we do not count on the debit side the costs of that progress in ugliness, depleted resources, or human anxiety.

An advanced industrial society is an intricate and delicately balanced kind of social order. It is extremely vulnerable, at many different points, to action by selfish groups that do not care if it works, or by hostile groups that do not want it to work. It can be held together either by spending an immense amount of money and effort on policemen, or by whipping up nationalist sentiments, or by so organizing itself that it has the voluntary support of the overwhelming proportion of the population. For too many of the people who must make our present industrial society work, it has become a study in absurdity. Its anomalies have depleted the reservoir of credit on which voluntary allegiance to it rests. The continuation of the sort of reforms that have marked the history of the last thirty years is an insufficient remedy, it seems to me, for this condition. An industrial society with a transformed order of priorities is needed.

This is why, despite the hard brilliance with which the view is often developed, I cannot share the confidence of those who speak of the future in terms of a "post-industrial" or "technetronic" era. This is the third of the four approaches to the future which I mentioned at the beginning. Those who speak of the "technetronic" age that is about to emerge base their projections on what they take to be the remorseless imperatives of technological innovation and industrial growth. From this point of view, our future political institutions will be institutions required to make technological organization work. They will be marked by increasing specializa-

tion of function, by the delegation of more and more authority to scientific and technical experts, and by the use of law and education to maintain islands of personal relations and personal liberty within an ocean of impersonal, bureaucratic controls. Efficiency—efficiency in communication and production—is the guiding and unavoidable desideratum of society so conceived.

But technological determinism seems to me to be as impossible to maintain as an approach to the interpretation of history as any other form of determinism. In fact, the habit of treating technological innovation as a thing in itself, as an autonomous sphere of human enterprise subject to only the most peripheral forms of control, is a recent habit in human history, only about as old as the industrial revolution itself. It belonged to an age in which scarcity was the central problem, not the uses of abundance; and even so, the doctrine that technological progress was a sacred preserve, to be shielded by society because society's fate depended on it, met with intense resistance. Neither intellectuals nor workers were universally persuaded by it.

In any case, our present civilization is replete with indications that the gospel of technology is not self-certifying. Our century is marked by a wide-spread sense of malaise and loss of confidence, by suspicion of the technocrats, and by growing hostility, in intellectual circles, in colleges and universities even to traditional notions of rational discourse. Efficiency is simply not enough as a political creed; people seek a sense of meaning in their social arrangements as well. And if the technetronic age cannot provide this sense of meaning, the political institutions needed to make it work will have to place steadily greater reliance on the external instruments of discipline.

The trouble with the technocratic view of the future, indeed, is that it is not usually technological enough. Technology has made options available for political choice that were not available before. Overcrowded cities, immense factories, massive bureaucracies are no longer necessities of economic organization; in fact, they are probably inefficient in strictly economic terms, and not only in broader human terms. The operative question for the future is not whether technological developments will control our social arrangements. The operative question is whether, by polit-

ical indifference or inaction, we will allow this to happen, or whether we will use political power to control the direction of technological growth and to make conscious social decisions about the best way to organize the economy. I do not underestimate the power either of old habits or old constellations of economic interest, and so I do not imagine that the control of the economy by the polity will be easy to achieve. But this is possible to achieve to a greater extent than has been the case so far, and it seems to me that the emerging moral and political expectations of our day make this possibility something more than a purely abstract one.

But this brings us to the fourth principal point of view which, so it seems to me, controls our current thoughts about the political future. It is a point of view which approaches the problem from the opposite end of the political spectrum. It recognizes technology but deplores it—at any rate as it is now organized. It speaks for personal liberation not economic discipline, for community not functional organization, for participation in the making of social rules as against bureaucratic patterns of organization, for intimacy and equality in human relations as against impersonal and formal hierarchies. It wants, presumably, the benefits of technology. But efficiency is not its overriding goal: the quality, the wholeness and integrity, of individual life is.

It is difficult to discuss this point of view. One runs afoul of certain annoying difficulties because it combines, as essentially poetic visions of the human condition so often do, moral vision and moral Quixoticism. It represents a surge of conscientiousness, and of new emotional and esthetic sensibility, which can greatly change our civilization, and in many ways for the better. We have taken for granted what we do not have to take for granted—social injustice, a dehumanized environment, a cult of productivity incredibly neglectful of the waste, human and material, that goes with it. But moral indignations and emotional disgust are not a political program. And they are barriers to serious politics and to the creation of more decent human arrangements if they are accompanied by moral self-righteousness and gross intellectual simplifications.

One of the intellectual simplifications in the new philosophies of social protest, I believe, is the degree to which these philosophies appear either to take technology for granted or to ignore it

altogether. It is one thing to say that technological efficiency is not its own justification, and that technology, like anything else, should be used by men in accordance with some rational scheme of human fulfillment. But in a world as heavily populated as ours, and as committed as it should be to the reduction of sharp inequalities in the lot of people in different classes, technology of a highly sophisticated sort is a necessity. And so it is quite another thing to say or imply that technology as such is an instrument for denying the essential humanity of man. A moral outlook with such overtones can be interpreted in only one of two ways: either it accepts the radical impoverishment of mankind or it presupposes a social order in which a class of helots maintain the industrial machine while a leisure class enjoys the benefits.

Moreover, this point of view misunderstands the social conditions of technological organization. While an industrial order can be put together in a number of different ways, any industrial order adequate to modern needs presupposes highly trained specialists, demanding intellectual disciplines, and a hierarchical form of economic organization in which authority to coordinate the work of large numbers of people is delegated to a rank of leaders and managers. And while it is possible and desirable to give individuals a larger voice than most now possess in determining many of the conditions of their life and work, there are also greater limits in an industrial society than in other kinds of society on the areas of autonomy that can be given to individuals and groups. The society is too intricately interrelated to allow decisions to be made by people only in terms of what is immediately in front of them. In a technological society more than in any other, distant facts, distant events and decisions, are part of what has to be taken into account in determining policy here and now. The frame of reference is national, continental, and intercontinental.

But there are oversimplifications in the new slogans of "community" and "participatory democracy" which go beyond their indifference or animosity towards technology. They arise, to speak bluntly, from utopian and sometimes internally inconsistent political assumptions—in a word, from bad political philosophy. We have heard so much about *participatory democracy* recently that I trust you will permit me to take the slogan perhaps more seriously than

those who use it regularly; I shall ask what it means. And I would add that in a very general way, as an expression of an emotion or a formulation of a broad kind of discontent with what exists, I do not find it objectionable.

On the contrary, it stirs an impulse in me to agree. Our present political institutions are often frustratingly unresponsive; and the distance betwen the actual facts of our present situation and the democratic credo, which promises that citizens will feel involved in their governments because they have some power over them, is so great as to represent a standing menace to the maintenance of free political institutions. Accordingly, I look upon the slogan *participatory democracy* as a welcome addition to the vocabulary of political criticism—a kind of whip which can stir us into the recognition of curable deficiencies in the received theory and practice of democratic politics.

But a whip is not a remedy, and a sense of deficiency is only the first step in the formulation of a problem. Moreover, if the slogan that whips us into a feeling of deficiency carries with it utopian or self-contradictory presuppositions, it can stir baseless, incurable and wasteful anxieties, and turn political thought and action down blind alleys. This is not a contribution to the improvement of the status quo but, if I may coin a word, to its *disimprovement.* And I believe that the new philosophies of personal community and participatory democracy have this effect. Let me try to indicate why I hold this view.

In the first place, let me ask, quite simply, whether participatory democracy, taken as a literal proposal for government, is a desirable state of affairs. Is it a state of affairs that any reasonable individual would really want if he thought about it quite concretely? Certainly, speaking for myself, if I want, in my own interest, stable conditions for free international trade, then the first thing that I would ask is that I be permitted *not* to take a direct part in decisions related to international monetary agreements. I assure you that I would contribute to confusion and folly. And all that consoles me in any ignorance and helplessness is my recognition that I am at least intelligent enough, reasonable enough, to absent myself happily and voluntarily from decisions involving such technical matters.

Of course, I want a chance to pass on the results achieved by the technical experts. If they make a mess of things, I want an opportunity to say so, and to do what I can to have them cashiered. And I am not so hypnotized or dazzled by the presence of professional knowledge that I think I can have no judgment about whether these professional specialists themselves have judgment or good sense. It is that kind of skill, not universal knowledge, which democracy asks of me as a citizen—a skill which permits me to distinguish between honest and dishonest men, sensible men and learned fools, imaginative men and narrow-minded ones. To make this sort of discrimination, I do not have to be a universally competent know-it-all. And if I can make this sort of discrimination, I will also recognize that, on a large number of matters, it would be unwise for me to participate directly in the making of decisions. All I wish—and it is quite enough to wish—is that I can pass judgment on the results of these decisions, and on the people who make them. So, in sum, if I were given the free chance to participate in all decisions affecting my life, my first decision would be to ask, in my own interest, to be freed from this dangerous invitation to misgovern myself.

Besides, and this is my second reason, I have other things to do with my time. I would rather deliver lectures on participatory democracy than participate, day in and day out, in political meetings. Everything in its own time and place. If I wish to specialize in government I shall do so. But if I wish to specialize in philosophy —or plumbing, or raising my children—I should like the opportunity to indulge this preference, and I would count it a mark of my freedom in a society that I am permitted to do so. (Forgive me for putting all this in so autobiographical a form. In an era in which so many insist that their personal tastes are universal laws of nature, I feel a special obligation just to speak for myself. But I suspect that a reasonably large number of other human beings, in all classes, may feel as I do.) For those who do feel this way, the obligation to be participatory democrats is a frightening thought. I don't mind participating; I don't mind drinking good wine: I rather like it. But not all the time, and not in response to a remorseless civic obligation. Must we be participators steadily, on all matters, large or small, interesting or boring, immediate to our competence

or distant from it? It is too easily forgotten that the ideal of participatory democracy began among the Greeks, who found it a plausible idea largely because it was limited to a small class of free citizens living on the labor of slaves. Though *participatory democracy* comes dressed in proletarian clothes, it is a leisure-class, not a working-man's ideal.

But the argument against participatory democracy does not rest simply on matters of preference. It flies in the face, I think, of certain stubborn sociological facts. Large groups of people meeting together to make decisions are not likely to come to agreement about what to do unless either powerful mob pressures are turned loose or they are manipulated by leaders. Disagreements are probable. And if this is the case, we are confronted by the age-old problem of politics of what to do about the losers—about the people who, for reasons good or bad, do not get their way. Do we expel them from the community of decision makers, or reeducate them? Do we try to provide arrangements that will allow them to make a come-back if they can? Participatory democracy, if it is thought through, means that people who do not get their way are tolerated; it means the recognition of honorable defeat, and the acceptance by the defeated of the decision against them. But this implies that there will be losers, and that a system cannot be condemned as repressive simply because the decision goes against some people.

Moreover, in most difficult social issues, the lines are not drawn neatly. There are not simply two opinions, two factions, but many opinions and many factions. Accordingly, the compromise of different views and the formation of coalitions are necessary. This is not possible in mass meetings. On the contrary, such meetings are mankind's best device for hardening disagreements. Compromises are best made and coalitions formed, if I may say so, in smoke-filled rooms. They are made by professional negotiators, by people who are willing to make deals. If what one wants from the political process is decision and action, and not merely conversation and drama, then citizens have to delegate authority to deal and negotiate to their leaders. The democratic element in the process consists in the control of the leaders; it consists in the electorate's power to renew their mandate or to choose another

group. It does not consist in direct participation at every stage in the decision-making process. Democracy, thought through as a practical process, is generally representative democracy.

So I have my doubts, as you will have gathered, about some of the new styles in political thought. I cannot predict the future, but I can express my desires about it. And if the future consists in the application of the ideal of direct democracy to political problems, then I think we are in for a future of systematic self-deception and disappointment—for a future of demagogy masquerading as popular rule, and of crowd psychology presented as spontaneity and freedom.

But where does this analysis lead us? What are the humane and reasonable options for the future?

They lie, I would suggest, in the concerted and deliberate effort, at the center, to decentralize our governing institutions. Technology and in particular modern communications technology make possible the creation of smaller economic and political units within which the ruled can be brought closer to the centers where decisions are made. The piling-up of decision-making authority in Washington or inside great concentrations of economic authority means that tired decisions are made and that bureaucratic inertia becomes the determining force. And it is not necessary; on the whole it is a product of excessively zealous defense policies and superstitions about foreign affairs. It is not a consequence of industrial necessities. Centralized government can set standards; it can, through its political and economic powers, strengthen the powers of smaller groups. But much larger grants of autonomy to subordinate centers are technically possible, economically desirable, and politically necessary. To reorganize our economy and polity in this way will take a major effort in structural reform. It will require not merely the granting of new powers to existing political institutions like states and cities which hold intermediate forms of authority and power. In all probability, it will also require the creation of new regional centers of governmental authority, which in their turn decentralize such powers as they can to political structures closer to the individual citizen. I do not imagine that any of this will be easy. But it is in such a redrawing of the political and

governmental map, I am inclined to think, that the restoration of vigor to our political institutions depends.

A second major strategy which, I believe, is of equal importance, is the systematic farming out of functions now carried on by government to nongovernmental or quasigovernmental agencies. If freedom for the individual citizen is in part a matter of the choices available to him, if efficiency is in part a product of competitive pressures, then there is a case to be made, I think, for stripping away from government bureaucracies monopolistic control over certain crucial social services. Why should postal services be a government monopoly? Why should the administration of social security programs? I entirely agree that the government has an obligation to guarantee the availability of these and many other services to all citizens. But this is not to say that government must directly perform these services.

In actual fact, our political system has already begun to evolve in this direction. Governmental needs and governmental funds have led to the development of a growing third sector in the American economy—an area of public, nonprofit enterprise supported by government but relatively freer from close Congressional supervision. The great obstacle to the evolution of our system in this direction, interestingly enough, is the outlook of the American Congress. The Congress has shown itself reluctant to authorize the expenditure of public funds without exercising tight, year-by-year supervision and control of the activities so authorized. However, in the emergence of a Public Television Corporation, and in discussions of the possibility of establishing public corporations to act in the area of foreign assistance or educational and cultural exchanges, we have the beginning of a newer political philosophy. The case for this political philosophy is not free from qualifications and reasonable doubts. I am inclined to think, however, that the future of political thought and political institutions lies in this direction.

If there is to be any future for refined political thought, however, and for free political institutions, innovation is not all that will be needed. Continuity of principle is also a requirement. A democratic system, a system of competition, compromise, and coalition, is workable only if the participants in it are prepared, by and

large, to treat their opponents as though they were sane and sincere. Moral self-righteousness, or the innocence which assumes that all decent men naturally hold not only the same ideals but the same notions about how to implement them, are incompatible with the maintenance of a free democratic order. They produce conditions in which people feel free to use force and violence and other people feel justified in replying in kind.

And more, they are incompatible because, in the immediate present, they represent attitudes towards one's fellows that spell condescension, disrespect for individuality, dislike of diversity, and impatience with complexity. These are not attitudes that make for a democratic ethic. Civility is a condition for a rational or civilized political future. It is often said that civility is a brake on change, that it retards alterations in the social order necessary in the interests of justice. Civility, admittedly, does retard certain changes; it retards the polarizations of society that last for centuries; it diminishes the tendency to substitute symbolic acts for genuine performance; it reduces the number of corpses. But there is no evidence that civility reduces the chance to make the lasting changes that contribute to the growth of justice and human compassion.

So we come back to the role of universities. For if they represent anything above the mere accumulation of knowledge or credits, they represent this etiquette of civility in human relations. To embody it is their supreme function. In this sense all members of universities—students, teachers, and administrators—are political actors. They are *engage,* whether they are activists or inactivists, partisans or nonpartisans. More than any other single factor affecting the future, what happens in our universities with regard to the maintenance of this etiquette will govern the future of political thought and political institutions.

CHALLENGES FOR TOMORROW

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A century ago, when Oregon State University was founded, the major challenges available to the young and energetic were very different from those of today and tomorrow. In the earlier times, great and exciting opportunities abounded. There was land to be settled; there were railroads, towns, and schools to be built. A generation later, industrial development of the region was proceeding, with emphasis on lumbering and other exploitation industries. Attractive opportunities were available in the field of engineering, for there were roads and bridges to be built, water and electricity to be provided, and land to be irrigated. Another major endeavor in which this university participated was the improvement of farming practice as a result of work of the agricultural experiment station.

In the 1930's great opportunities were open in science and technology. The chemical basis of life could be elucidated and antibiotics discovered. Understanding of organic chemistry was leading to many new products, including plastics. Developments in electronics were pointing toward television, radar, and high-speed electronic computers. The atomic nucleus was opened to exploration, and suddenly nuclear energy loomed as a potentially constructive and destructive force.

During the past hundred years each generation has faced changing and exciting challenges that have provided ample scope for the most imaginative, intelligent, and energetic youth. What

are the challenges for tomorrow? In this presentation I propose to furnish some answers to that question.

In selecting a life's work or a target for one's activities an overriding criterion is to identify goals which will be relevant and sufficiently significant. What do we mean when we talk of relevance and significance? We are referring, of course, to other people and to their judgment or taste. Unless we are hopelessly self-centered, our goal is to be associated with activities or accomplishments that are regarded favorably by others. We are especially desirous of the good opinion of those considered to have excellent judgment. We would prefer that our accomplishments have enduring, rather than fleeting, impact.

Of great, enduring significance to all humans is an important set of problems growing out of science and technology. It seems clear that the society of the future will be shaped by technology. The great challenge is to shape it wisely.

A few hundred years ago, most men barely managed to eke out a livelihood by working at hard labor from dawn to dusk. Famine and pestilence were familiar visitors. Life expectancy was not much more than 30 years. Then, in a relatively short period, man changed his way of life. Science gave man knowledge, and through technology that knowledge was utilized to create unprecedented power and many options for action. Today man is master of his destiny, but he is sorely troubled.

Faced with the many puzzling problems of a complex society, there are those who say, "Stop the world. I want to get off." One can sympathize with them, but we should remember the experiences and attitudes of the Apollo 8 astronauts. They had managed to get off our planet, but after taking a good look at the moon, their fondest hope was to get back to this good earth. A little reflection will convince us that there are only two alternatives for society—learn to cope with and manage the problems created by technology or return to the poverty and pestilence of the Middle Ages. If technology were suddenly to disappear, there would be indescribable chaos and misery in the land, and after a year only a small fraction of the population would remain alive. The matter can be put in a softer light, but the final picture is the same. Many people now yearn for the fresh, unspoiled wilderness that existed

in this country when the white man first arrived. But in the winter time, who wants to live in a wigwam? Instead of gazing back at good old days that really were not very good, we can more usefully look ahead.

But first we should ask, "Why are we so troubled?" I believe it is because we now have far more wealth, power, and leisure than we can at this moment deal with wisely. Moreover, as Lee DuBridge[1] has recently pointed out, we have become so accustomed to the almost magical capabilities of technology that we expect instantaneous solutions to all problems, no matter how complicated. This demand is unreasonable, even when the problems are purely technical in character. However, rosy expectations are just plain foolish when complex, political, and ethical considerations are additional important factors. Our problems in adjusting to the new situations are great enough already without the further complication of attempting an instantaneous response.

When people witness an accomplishment such as that of Apollo 8 they are impressed with the power of American technology. They are inclined to say, "If we can do that, we can do anything." They are also inclined to believe that we can do everything —that given the goal and the money, technology can be bent to the accomplishment of any and all tasks. At present, the United States has the world's most affluent society, and it appears to be a world leader in all aspects of science and technology. The future *seems* secure. In fact, it is not secure, and fairly soon there will be a rude awakening to an unpleasant situation. Our present affluence is not assured; its underpinnings are eroding.

One of the challenges of tomorrow will be to cope with scarcities. At the beginning of this century, this country was the world's leading miner of gold. Today we produce a small fraction of the total. At that time we had vast supplies of copper ore, the grade of which ran about 2 percent copper. Today the average grade mined has dropped to less than a third as much. Once we were a great exporter of iron, lead, and silver. Today we are a net importer of these items. Once the United States was a leading exporter of pe-

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[1] Hearings on H.R.35 (Miller Bill), Subcommittee on Science Research and Development, House Committee on Science and Astronautics, February 19, 1969.

troleum, and now we import about $2 billion worth a year. So costly have our net imports of raw materials become that they are an important factor in our international solvency. Our favorable foreign trade balance has been shrinking rapidly. In 1964 it was more than $6 billion, and through much of the sixties it averaged about $4 billion. Last year the favorable trade balance shrank to $0.8 billion. A major part of the shrinkage is due to increasing imports of raw materials. Another factor is the emergence of strong competition by Japan and West Germany, both abroad and here at home, in products involving high scientific and technical capability.

To maintain solvency, we must find new sources of raw materials, develop substitutes, or improve our competitive abilities in world trade so that we can pay for imports of raw materials. All these possibilities involve, among other things, the requirement that our science and technology be highly competent. In a continuing search for efficiency, industry is evolving fairly rapidly.

In the future most of our material needs will be met by skillfully bringing together science, electronic data processing, engineering, management, money, raw materials, and energy. Evolution brought about by electronic data processing alone will guarantee great changes. For the longer haul, however, perhaps the most significant component in shaping technology will be the means by which energy is obtained and applied. Our high standard of living too is based on the use of various forms of energy, such as electricity or the energy obtained from internal combustion in automobiles.

During the next generation, significant changes will occur in the means by which demands for energy are filled. Use of nuclear energy will increase rapidly, especially in large electric generating plants. For most applications, however, the practical source of energy is in the form of hydrocarbons like oil and gasoline. They are burned extensively in power plants, but their greatest use is in transportation—including planes, trains, and automobiles—and in space heating of, for example, homes. It is difficult to visualize life without them. Yet we must give thought to the matter, for our supplies of petroleum are limited and are being exhausted. Since we cannot afford to supply our increasing needs by importation, we

will have to meet them in another way; that is, by obtaining a larger fraction of our hydrocarbons from coal and from oil shale.

Second in importance to energy is the need for raw materials. Present patterns of obtaining and utilizing them cannot long continue. New sources must be found, and discarded wastes must be reused. The possibilities of the oceans and their dissolved salts will be exploited. Great new industries will tap the tremendous resources of the ocean bottoms. Among the materials of possible economic significance on the deep sea floor are manganese nodules, which contain many other elements besides manganese. The continental shelves, rich in oil, gas, and sulfur, are already being increasingly exploited.

The availability of raw materials will influence the nature of future living patterns. Quite apart from scarcities, however, man will be forced into new attitudes and practices by the problems of pollution and waste management. Today there is increasing concern about these matters. Athelstan Spilhaus of the Franklin Institute highlighted the problem when he wrote:

> *Our whole economy is based on taking natural resources, converting them into things that are consumer products, selling them to the consumer, and then forgetting about them. But there are no* ***consumers****—only* ***users.*** *The user employs the product, sometimes changes it in form, but does not consume it—he just discards it.*[2]

The production of solid wastes in this country has now reached eight pounds per person per day and is increasing. Many cities, having exhausted their cheap sites for dumps, must haul refuse farther and farther away. One of the best solutions to our waste-disposal problem is to recycle many of the materials instead of discarding them.

For emphasis I will summarize my major conclusions thus far. Instead of a guaranteed affluence we face the prospect of scarcity and of great changes in the means by which the material needs of our people are met. During the next generation we will either

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[2] "Waste Management and Control: A Report to the Federal Council for Science and Technology," Nat. Acad. Sci.-Nat. Res. Council Publication 1400 (1966), p. 5.

respond to the evolving realities or we will follow the path of Great Britain, watching while others lead.

In the future the challenge of meeting human material needs will be great. At present this challenge is overshadowed by greater ones in the form of ethical problems. Unprecedented developments in science and technology have altered many of the circumstances upon which previous codes of behavior were based. At the same time the influence of the church has diminished. Thus we are faced with the need for developing new views of ethical standards at a time when traditional sources of guidance have lost some of their authority. As an example, consider a particularly difficult set of new ethical problems that has arisen because of advances in biology and medicine. Earlier, mankind was subject to a form of Russian roulette in which microorganisms were the lethal agents. In that era populations were repeatedly decimated. Medical discoveries now protect populations so that they grow explosively. Other advances make it possible to keep alive, almost indefinitely, very old and very sick people. Recent discoveries in the field of inborn errors of metabolism allow biologically defective individuals to reach maturity and reproduce. Advances in genetics raise the possibility of rapidly altering human heredity.

The population situation is not yet acute in this country. Our rate of increase has tapered off, and we do not face an immediate crisis with respect to food. By exploiting technological potentials in the synthesis of chemicals, this country could achieve the capacity to produce enough food to feed many times the earth's present population. Should we go down that road? Should we make an all-out effort to convert the world into an over-crowded slum? The population increase already affects our lives in many ways. When there are too many people—too much social contact—the milk of human kindness curdles. It seems unlikely that the western attitude toward sanctity of life can survive the impact of greatly increased numbers.

All of us are confronted by choices with respect to the population explosion. For instance, what is the desirable population level? What are the factors that determine it? Who will set the level? How will such a level be enforced? Who will be allowed to live? A form of the question of who will be allowed to live is already an acute

problem for the medical profession, especially in connection with the aged.

Out of science have come developments which, applied to medicine, have made it possible to prolong life. With use of artificial respiration, artificial kidneys, transfusions, and antibiotics it is possible to keep alive very old, very sick people. The public expects physicians to make every effort to save life. Indeed they must make every effort; to do otherwise would destroy a great human value—the faith of the public in their doctors. Yet the time comes when there is no possibility of restoration of useful life and when the spirit, and even health, of the immediate family is being seriously eroded. A generation ago, as death approached, the family could take whatever comfort they could find in the phrase "It's the will of God." Today the issue is in less omniscient hands, and physicians must make decisions previously reserved for the Almighty. Physicians realize that they must try to keep such patients alive, but they believe that the effort can do harm to society. Care of a moribund patient requires a tremendous amount of work by many people. Most hospitals are understaffed, and care must be rationed among patients. Under such circumstances the needs of deserving patients may be overlooked. For example, young persons critically injured in automobile accidents might not be given an optimum chance of recovery owing to the competing requirements for attention. The time and facilities devoted to one unconscious patient in the course of a year could be denied to a score of patients having the prognosis of complete recovery.

Physicians and others face grave ethical questions in this area. Viewed in a long-term perspective, however, the problems do not seem nearly so serious as some others having to do with genetics. With scientific knowledge has come the means to manipulate and control. As more knowledge is gained concerning genetics, many methods will become available for shaping man's genetic make-up. Who is to use those tools? What will be their objectives? Who will be allowed to reproduce? Will individuals be licensed by government?

These questions need not be answered immediately. The answers, however, may become urgent before we are fully prepared to give them. At stake is the future of the human race, and

man would do well to bring wisdom and reflection to these matters.

Turning from these biological questions to the more prosaic ones of our environment, we have only to look around us to see that there are a host of problems—air pollution, water pollution, conservation, and the like. In meeting our physical needs, real or fancied, we have been a relatively greedy and improvident nation. We have had a cavalier attitude toward our environment and toward our resources. We have acted as if there were no tomorrow. But there will be a tomorrow. If it is to be a good tomorrow we must begin to act as if we believe that our descendents should have a decent future. To guarantee that they in fact have a fair chance, we must weigh as never before the consequences of our actions. We must develop a value system that will help us meet a host of pressing problems but, at the same time, be compatible with longer-term evolution of the human race.

Insofar as we have had a value system during the past decade, who and what have shaped it? In part, our values have been derived from traditional sources like the church, the educational system, and our parents. Our traditional sources of values were largely future oriented. For example, the church taught us to spurn gratifications of the moment and instead prepare for the future. Today, however, the influence of all these sources of guidance has diminished, and our value system is tending to be oriented to the present moment. Major new factors include the mass media, particularly television. For the most part, those who control TV are influenced mainly by what will produce immediate financial gain.

Since the mass media derive most of their revenue from advertising, the material that they present is accordingly influenced by the advertisers—some of the nation's most powerful corporations. I am not here to criticize industry or its influence on the public. The managers are not devils; they are humans like the rest of us, responding as best they can to events and pressures. One of the greatest pressures exerted upon the president of a corporation is the requirement that his company experience an annually increasing profit. This year must compare favorably with last year. This pressure tends to orient him toward expediency and a short-term outlook. There are, of course, notable exceptions, but in gen-

eral, big industry is predominantly oriented to the immediate and to the short-range rather than to the long-range future. As its agent, industry uses Madison Avenue, whose objective is to make us want things. Some of the things are good, useful means for meeting real human needs. In many respects, however, Madison Avenue has the vision and morals of an alley cat. We are urged into buying things we do not need. We are pressured to use a great assortment of medicines that will certainly do little good and may be harmful. Sex is used to glamorize all kinds of merchandise. By its prostitution to the tobacco industry, Madison Avenue participates each year in the deaths of tens of thousands of people from heart disease and lung cancer. We will get little worthwhile ethical guidance from commercial TV.

Another source of goals for society is the politicians. At their best, politicians operate constructively, using the art of the possible in establishing desirable goals for mankind. Leadership in the effort to fight pollution has been in the hands of the Congress, and the Senate particularly has acted in an informed and statesmanlike way. Not all the politicians are so wise. One of their worst weaknesses is a tendency to overreact to a passing crisis. A politician who does not respond to the mood of the moment is not likely to stay in office. Few of them are so secure that they can afford to look beyond the next election.

Thus, we see that three powerful forces shaping society (the mass media, industry, and the politician) are oriented to the short-term outlook while the traditional sources of guidance that emphasized the longer view have been weakened.

Another group that has recently been providing goals for society is the scientists and engineers. It is by no means a homogeneous group. Among its members are many public-spirited, thoughtful people. By and large this group is future oriented, but at least some of its members have advocated courses of action that may well be criticized. Included in the group are action-oriented individuals who have advanced the guideline. "What man can do, he must do." If leadership resided with such people, we would engage in heaven knows what kind of modern pyramid building. We would do unpredictable violence to our environment.

The most influential leaders of science today, however, have turned away from the what-man-can-do-he-must-do slogan. Instead, opinion has crystallized around Roger Revelle's[3] view that our goal should be, not to conquer the natural world, but to live in harmony with it.

We cannot afford to permit narrow or special-interest groups —be they Madison Avenue, politicians, or engineers—to have a dominant influence in shaping our goals. We must find better ways. One possibility is a revival of the influence of the church. This will come about if the church becomes more in tune with the times and the problems. I see some evidence that this is beginning to happen. Lately I have encountered members of the clergy who are knowledgeable about scientific and technical developments and who have given thought to the moral consequences. For instance, in the nation's capitol Canon Hamilton of the Washington Cathedral is quite a scholar in the field of biology. One of his recent sermons contained an excellent summary of the latest developments in genetics. Few professional biologists could improve on his exposition. Canon Hamilton has also been educating many of the clergy in his area. Were his example to be multiplied, we would soon begin to note the effect of a powerful voice.

In addition to the clergy, society as a whole must participate in shaping values. In that effort young, well-trained, public-spirited citizens will have an important role. We should not underestimate the capacity for good judgment that resides in men of all walks of life. Nevertheless, there is a special niche and need for gifted individuals who, though capable of thinking for themselves, are happy to learn from and respect the views of others. We will need men and women, conversant with the potentials and limitations of science and technology, who also understand the aspirations, potentials, and limitations of human beings—in other words, men and women who, while giving their minds to science, give their hearts to humanity.

In dealing with the multiplicity of problems faced by society, I believe that some of the systematic modes of approach em-

[3] Quoted in Daddario, Emilio Q., "Science Policy and the Hidden War," remarks given at the State University of New York, Albany, N. Y. (inaugurating the Center for Science and the Future of Human Affairs), March 17, 1968.

ployed by scientists might be useful. First, we need to enumerate the problems. Then we need to examine their nature in detail and assess their short-range and long-range importance. We need to identify in detail the primary elements of the problem. Some problems may be amenable to a technological solution. If technology does not seem to hold the answer, the paramount question may be largely ethical in nature—for example, the prolongation of life in the aged.

Another essential element of any given problem is the composition of the groups who are vitally concerned. Some types of environmental pollution, for example, involve a single community and a single corporation. Other pollution problems touch a region and many corporations, and may require the participation of the federal government. Other types of pollution, including radioactive fallout and some pesticides, affect every country and every inhabitant of the globe.

Problems such as the prolongation of life have as essential elements the medical profession, the church, and the individual. Ultimately, with Medicare, an increasing fraction of our gross national product could go into efforts to prolong the lives of aged and moribund patients. At that point the public and the political system would also be drawn in.

Some problems involve primarily the individual wrestling with his conscience. An example of special concern involves science. When a scientist produces knowledge he knows that it is likely to be used. Once news of the discovery is publicly released, the scientist loses forever his ability to control the ways in which that knowledge may be employed. Almost all knowledge can have socially good applications and socially bad ones. The fire that warms the hearth can destroy the home. To a certain degree society can be counted on to emphasize the constructive rather than the destructive, so that the knowledge should probably be released when a rough balance of good and bad application can be foreseen. In principle, however, there could be new knowledge which would have few foreseeable constructive applications while having many destructive potentialities. In that event the scientist would face the need to wrestle alone with his conscience and decide

whether to suppress his findings, knowing that soon others would independently discover the information.

Another important characteristic of the current problems facing mankind is that some can be solved fairly swiftly whereas the solution of others may require considerable time. A realistic estimate of the time factors associated with a problem is often essential to designing a practical cure. New York City and environs, for example, had a serious air-pollution problem arising from the sulfur content of fuel oils. By a scheduled progressive lowering of the permissible sulfur content of the fuel, New York is achieving cleaner air. Industry has cooperated. Had New York demanded in 1967 what it practically could not get until 1970, however, the lawyers would probably still be squabbling. Moreover, industry could not have built new refinery facilities to supply the cleaner fuel oil. Most of our pollution problems can and will be abated if steady pressure to do so is maintained. However, development of the necessary technology and construction of new facilities may require a decade or more.

Another lesson from the scientific approach is the need to establish general laws. In ethics there are already some great principles—the Golden Rule, for instance, gives guidance in many situations. An example of a possible useful rule is the principle that man should avoid taking actions that jeopardize the long-term prospects of a happy future for mankind. Many of our present ethical problems would become simpler if this principle were widely accepted.

Gifted people acting individually can make substantial contributions toward filling our present ethics gap. Clear, creative thinking begins, of course, with the individual, but given the complexity of the issues and the powerful elements involved, few individuals thinking and acting alone can be very effective.

Group interaction has important benefits. It permits the individual to check his ideas and to obtain constructive feedback. The individual should give special thought to the composition of the group he consults. That is, a chemist who talks only to chemists is likely to consider well the chemical aspects of a situation but often will not be aware of other essential components. If the individual wishes to tackle a complex problem that touches many

elements of society, he should attempt to be in contact with representatives of all those elements. If the ideas are sound, they are likely to receive the support of the group. A broadening of the discussion group sharpens the ideas and enhances the chances of ultimate widespread adoption.

Many of the problems affect the interests of large, powerful corporations. The only force capable of dealing with such power is the political system. Group activity is one of the most effective means of influencing that system. As an editor, I have often been impressed by the receptivity to ideas of congressmen, many of whom are public spirited and eager to be in contact with intellectuals. Because congressmen must protect themselves from unceasing communications from crackpots, they do not pay much attention to letters or appeals from the ordinary individual. Ideas sponsored by a group or an organization, however, receive a different level of attention.

I have surveyed some of the challenges facing us and have pointed to many puzzling problems. It would be easy to be pessimistic. I am optimistic, nevertheless, for I believe that man will learn how to harness technology successfully and will deal wisely with many of the deleterious substantive by-products of technology, such as pollution. There are limitations, of course, on what technology can do. It cannot rescue society from unbounded folly: it cannot, for example, cope with an unchecked population explosion. At the same time society must use restraint in the way it employs technology. Society must not exercise every option that technology provides—all-out nuclear war, for instance. Technology has given us wealth, power, and the ability to mold the environment. Whether mankind has a long and happy future will be determined by the wisdom and restraint with which we choose our courses of action: (1) The population explosion must be curbed. (2) Man must not engage in nuclear war. (3) Man must learn to live in harmony with the natural world.

The big uncertainty is not "Can man learn to live with technology?" but rather "Can man learn to live with man?" On this question I lean toward a *yes*. Most people learn only the hard way, but they do learn, for misery is a good teacher. From cruel experience come judgment, realism, and avoidance of folly. The urge

toward preservation of self and of society is deep. When man finally realizes that long-term survival is at stake he will grudgingly do the required tough-minded thinking and take the necessary measures. And so reasonable, constructive answers will be found to most of the ethical and technological problems that face mankind. As time goes on, new problems and new crises will arise. That too is good, for man is restless and forever reaching out. If the time comes when he cannot identify great problems, sober citizens should really worry—the essence of the human spirit will have been lost.

MEN AND MACHINES

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THE relation of man to machines is the muddle of our age. We have created the machines and yet we have trouble in making our peace with them. There are those who believe that machines and the technology behind them are running away with humanity and should be stopped or at least regulated. Other people believe that only new technology can provide the cures to humanity's ills. As an engineer, I am attracted by the latter viewpoint, but I am not entirely convinced.

I am willing to admit that all is not well with men and machines. We need to know more about how people and societies are human and how to keep them that way in the face of our increasingly technological society. I believe that the answer is to be found in education and, in particular, in the idea of technological literacy for all responsible citizens. That is my theme today and I want to make the case for technological education as a part of cultural education and say what the subject matter might be.

The influence of technology on societies and on the lives of men is too well known to require comment. Less well recognized is the influence of technology on the nature of man himself. Somehow we tend to think of man as constant and immutable. Only his environment and his modes of travel, communication, and work seem to change. As in centuries past, man is still hampered by his jealousies, his selfishness, and his primitive instincts. He still survives through his unique mental capacities, his compassion, and his sense of individual worth. There is certainly some truth

in this view of the constant man, but when assessing the interaction of man and machine, it misses the crux of the matter.

Modern man is as much the product of his own technology as the technology is a product of man. This unity of man and technology is being recognized and interpreted today by many scholars, perhaps the most flamboyant being Marshall McLuhan. His cryptic observation that "The medium is the message" in modern communications strikes at the heart of the matter. The mere existence of "media" has altered how man is human. For example, communication technology *has* changed the nature of man.

Television has brought the world in view for almost all Americans, most Western Europeans, and many people elsewhere. The world is no longer somewhere else; it is in that electronic box in the living room, bedroom, or den. Whether or not the picture projected is an accurate portrayal of life is beside the point. The critical fact is that all viewers in the U.S., regardless of their station in life or their economic status, see a convincing portrayal of middle-class affluence and material wealth. The underprivileged want to share in this way of life, while many young people reject the whole system as overly materialistic. Indeed, many scholars believe, and with good reason I think, that TV and TV commercials in particular are at the root of much unrest and dissatisfaction in our country.

In many primitive countries, TV is being used to generate a unity of purpose and to popularize national goals. When my wife and I visited Egypt a few years ago, we found that the only subsidized industry was the manufacture of TV receivers for sale to the populace. An earlier project in Mr. Nasser's regime set up TV transmitters at four places along the Nile. These cover over ninety-five percent of the UAR's citizens, who can watch programs in government-sponsored community centers if they do not own sets. Though we could not understand Arabic, we were convinced by a short look at the picture that the programs were principally to inspire patriotism and nationalism. TV is effectively supplemented by Radio Cairo, sending to the millions of transistor radios carried on every cart, felucca, and camel. TV and radio play a very significant role in the Middle East today. More to the point here, the terms in which people view the real world as they live in it are conditioned by the existence of a visual communication medium. Television has

extended man's visual sense so that it now encompasses the world and beyond. The mere existence of TV has changed the way people think and act. Similar arguments have been made for the automobile, the telephone, the tape recorder, the computer, and so on. Soon PICTUREPHONE sets, video-tape recorders, home computer terminals, and remote library services promise to have their influence.

Regardless of specific claims, man is different today than in millennia past, and he will be different in years to come. Technology has and will play a prime role in this evolution. So, the notion that technology is neutral and man makes of it what he will, good or ill, seems at best short-sighted. For example, if we inquire about the impact of technology on education, we are asking much more than merely how technology will enter the educational process and how it will influence teaching methods, curricula, and student-faculty relations. We are asking what new demands will be placed on education as man changes in response to the increasingly technological world about him. In the long run, these new demands are likely to be more significant than the impact of educational technology itself, for new technology is likely to have its fundamental impact on the public and people generally before that technology appears in educational institutions. The impact of television has certainly followed that course; it is only beginning to be used in education.

Not only do technology and machines influence how people are human; they also determine the shape of society. For example, sociologists are beginning to recognize imaginary, or virtual cities as opposed to real ones with their overcrowding and their problems of transportation, health care, waste disposal, air pollution, and all the rest. The *virtual city* is the city formed by communities of interest in which person-to-person contact is accomplished by electrical communication, rather than physical proximity. The virtual city is the city of cultural ferment without the physical concentration and its ills. The key to the virtual city is the communication channel and the jet airplane.

We will not do away entirely with the physical city, of course. There will still be a need for physical proximity if for no more than shaking hands or kissing. But, new communication and transporta-

tion machines are already making it unnecessary to live in proximity to one's associates. I, myself, commute often to Washington or Boston for the day from New York. It is just as feasible to do so between Los Angeles, San Francisco, and Seattle and between mid-America and the Coasts.

So, in spite of the size of our country and the dispersion of industry and the population, people are becoming more and more interdependent. This increasing dependence extends not only to people in the same city but to people all over our country, and indeed between people in the whole world. This effect is certainly one of the main influences of technology and machines on society. It is also a major influence on the way we live our lives.

This close coupling of people-with-people into larger, more complex societies and the changing nature of man, all mediated by technological machines, is not the only factor escalating the influence of machines. Technological ways of thought are invading our culture from many sides. These ways of thinking are becoming relevant to a much broader scope of human activity than merely engineering and science. Today we find common concepts in science, engineering, economics, medicine, business methods, pedagogy, urban planning, psychology, political science, library and information sciences, and even the arts and humanities.

The concepts common to such a variety of fields concern the organization and control of complex situations. These situations may or may not contain technological devices but they are all responsive to the existence of technology. For example, it is common in Washington for economists and planners to use computer models in making decisions concerned with public policy. Results from such model studies are not infallible, nor do they relieve people from making hard decisions, but the technique of sharpening one's intuition by framing ideas precisely and following through their consequences before taking action is increasingly vital as man attempts to deal with more and more complexity. Measurement, too, is replacing guesswork in many fields. Measurement of voter attitudes, for example, is becoming widely used in planning political campaigns. Still other widely-used concepts include stability, optimization, prediction, and value in decision-making.

Not only do machines change us individually and shape our

society, but techniques from engineering and science are determining the directions of its evolution. The danger grows that fewer and fewer people will be in a position to exercise influence over the choices which affect us all. In my view, broad participation by the populace calls for a new standard of technological literacy. Only this will prevent a power gap from developing between those who "know" and those who "don't."

But, technical knowledge is sometimes depicted as outside our culture; as the antithesis of humanistic thought. The extreme viewpoint is crystallized by the "anti-machine" people and, of course, they are opposed by the "pro-machine" people. I am reminded of a remark by one of my colleagues who was discussing artificial intelligence research. There is a continuing controversy about the possibilities for artificial intelligence; namely, will computing machines be able to out-think man—that is, be creative beyond what could be expected of the human mind? This controversy is highly polarized; an example: one person has said that artificial intelligence is principally real stupidity. As you can appreciate, this argument is sometimes carried on by articulate but less than clear-thinking spokesmen; some have called them "crackpots." It was in discussing the qualifications of various people in this field that my colleague remarked, "You can tell the crackpots—they are on the side of the machine!" Yes, there is no difficulty in finding people on the side of the machine, though in a different sense than that which brought the crackpot remark. For instance, Charles P. Lecht, certainly no crackpot and president of the Advanced Computer Techniques Corporation, quite a philosopher in his own right, is quoted in a recent *New Yorker* magazine: "The avowed enemies of the machine are the machine's only true friends. . . . It would be much more realistic and honest of them if instead of fearing the machine, they feared their own ignorance of the machine."[1] He goes on to point out that in order to lessen the effect of the machine, humanists must know the machine.

A corollary view is projected by E. G. Mesthene of Harvard. In a *Saturday Review* article, he points out that society's current belief in the ultimate intelligibility of the universe leads us to be-

[1] *The New Yorker*, August 19, 1967, p. 25.

lieve that we have the technical capability to do very nearly anything: "Can we live on the ocean bottom, control personality, order the weather to suit us, travel to Mars or to Venus? Of course we can, if not now or in five to ten years, then certainly in 25, or in 50 to a 100."[2] He goes on to say that the important question today is not "What can we do?", but "What should we do?" a question which requires value judgments based upon technical understanding.

Perhaps I have been beating a dead horse; perhaps few would argue with the goal of technical literacy for tomorrow's citizen. In any case, let me now say how it might be achieved. I believe that this literacy ought to be based on knowledge of technology as opposed to science interpreted as pure knowledge. After all, today's citizen is surrounded by the products of technology—everything from jet airliners and color TV to copying machines and automated teaching devices. It is this world, the *man-made* world, that the citizen must comprehend. Traditionally, knowledge of the natural world is a part of our culture, but the idea of technology as a part of the academic curriculum goes against the grain, for the teaching of technology in the past has concentrated on devices—the word "hardware" is often used instead of "device!" The implication to me is that technology is isolated from both intellectual and humanistic thought. If it indeed is, then it is just this isolation that must be relieved.

The notion of technical literacy is at the base of the effort which has developed into the Engineering Concepts Curriculum Project. This effort, of which I am co-director with Professor John G. Truxal of the Polytechnic Institute of Brooklyn, aims at developing a 12th grade course which, though technically based, is suitable for college-bound students regardless of their eventual educational destiny. I must say we have found this a demanding task. The complications and difficulties can be appreciated from a definition of high school science by a wise high school teacher: He said high school science is composed of black boxes, red tape, green teachers, and yellow administrators! Seriously, looking back on this effort which has extended over the past four years, we

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[2] "Learning to Live with Science," *Saturday Review,* July 17, 1965, p. 14-17.

have had to confront the basic issue: what to teach the future citizen about science and technology as a part of modern culture. Before trying to answer this question, let me say a few words about the genesis of our effort.

In the fall of 1963, the National Science Foundation held a meeting in Washington, D. C., to explore the question: "Are there desirable approaches to the study of physics and physical science in high schools other than those presently available?" Discussion was spirited, but most of the conferees left convinced that the enormous range of student interests, inclinations and aptitudes could be well served by several alternative approaches. Some of us who attended that exploratory conference shared a strong interest in engineering. We thought that the engineering viewpoint offered an opportunity for a radically different approach.

This viewpoint, oversimplified to be sure, is merely that engineering is synthesis oriented and is purposeful. It is inspired by Bacon's view that knowledge can often be used to better man's lot. It is from this notion of knowledge and relevance that the Engineering Concepts Curriculum Project was begun. Out of this effort has come a course entitled "The Man-Made World."

Let us return to the question, "What should be taught?" The multitude of man's artifacts, which so influence his life today, is indeed impressive. However, to teach about some particular artifact or artifacts without a unifying framework would be of little lasting value to many students. Rather, we managed to identify certain generalities common to many artifacts. Some of these generalities were new to the list of concepts usually taught in schools. The additions were largely oriented toward systems.

What do we mean by a system? Basically, a system is an entity whose properties are dependent on the interaction of a mutlitude of parts. More succinctly, a system is *organized complexity*. Systems are of many sorts; everything from electronic digital computers and earth satellites to the world's monetary structure and animal brains are systems by this definition. Significantly, there are principles of organization which appear relevant to systems across the board. One such principle is that of feedback, for example. I like to think of feedback as the control of cause-by-effect rather than the usual control of effect-by-cause. In any case,

you can appreciate that such principles can be divorced from hardware devices themselves. It seems to me that technological literacy should be based upon principles of this kind.

Note that man-made systems require an approach different from natural systems. There are two ways of examining any system, the atomistic way and the holistic way. Many natural systems are so complex—by that I mean that the interactions between their parts are so strong and complicated—that the usual method of breaking the system down to its parts for analysis is discouragingly ineffective. The human nervous system is an example of a system which yields to a holistic approach, but has proved resistant to atomistic decomposition. Progress has been made by considering large assemblages of neurons as wholes, the assemblages being considered as basic units in themselves. There are many other examples in physics, psychology, and other fields.

Natural systems often are holistic; natural atomistic systems are scarce. In most man-made systems, however, great care is taken not to create holistic systems. Digital computers, for example, are constructed by rules and disciplines which make the whole understandable from the ground up, so to speak. This kind of understanding based on hierarchical structure is rare, but it is extremely powerful in creating a technically rational world. This idea is a basic one for technological literacy and is presented in "The Man-Made World" text. It treats digital computers in exactly this fashion, beginning with simple switches and ending with a simple but representative symbol-manipulating computing machine.

The atomistic approach to synthesis in the man-made world leads to the second major concept, that of modeling. A model is a simplified version of reality—an idealization—the representation of some essential aspect of a situation, for example, by mathematical symbols, by a physical replica, or by a computer program. Technology shares the notion of modeling for understanding with the pure sciences, a fact which makes it difficult to tell where science ends and engineering or technology begins. Modeling is basic to understanding the behavior of systems and subsystems, natural and man made. More to our point, modeling underlies the synthesis and organization, that is, the *creation* of systems. Modeling is

the essence of rational decision making, of prediction, and of optimization. It is in these topics that the concept of value and its vital role in setting goals can be demonstrated. Here human judgment is vital.

This discussion, I hope, gives the flavor of the subject matter of "The Man-Made World." Its aim is technological literacy for the future citizen.

But technological literacy is not enough, for despite computer models and such, there is no royal road to predicting exactly what influence some new technology may have on man and society. Yet, it is increasingly vital to be able to do so. Many influential people are realizing this today. A prominent one is Representative Daddario of the U. S. House of Representatives who has initiated studies on what he calls "technology assessment." That is a slight misnomer, for Mr. Daddario aspires to assess the effects of future applications of technology, not an evaluation of technology itself. At his urging, the National Academy of Engineering is studying just how feasible it is to predict the influences of technology. My own thoughts on this subject are that paper assessments, no matter how logical or rational, no matter how insightful and distinguished the evaluators may be, will not be entirely adequate to set the directions for the application of technology. For example, to those who have studied educational technology and computer-aided instruction, it is perfectly clear that these will increase the costs of education, not decrease them as some proponents claim. Other judgments of this kind can be made, but various aspects of human reaction to automated instruction are far less clear. In such situations, experimentation is a necessary adjunct to assessment. This is not a new idea, of course; many products and services undergo trials before they are put into full-scale production or offered to the public generally. What is new is that such trials, I like to call them system experiments, are being applied across a much wider range of activities. Furthermore, the questions and issues to be investigated are being formulated precisely and the trial designed to produce answers. Many of these experiments have strong social overtones. For example, you may remember that an experiment on the effects of sonic boom was carried out a few years ago in Oklahoma City. The residents were subjected to

sonic booms generated by supersonic aircraft overflying the area. Measuring the reaction of Oklahomans in a meaningful way proved to be difficult. There is a 105-page report on the subject, but that material has not received adequate publicity, probably because it is difficult for the lay person to interpret the results in terms of the basic question, "How objectionable is the sonic boom?"

This re-emphasizes the importance of citizens having the knowledge to understand the significance of experimental and technological facts in terms of their social impact. If citizens lack this understanding, they will be afflicted with the tyranny of the "experts" who are not answerable to the people affected by their interpretations and decisions.

To conclude, let me summarize briefly. Man and his machines are not isolated islands interacting with one another. The very nature of man and his societies is determined by the machines which man creates for himself. In this time of rapidly advancing technology, it is becoming increasingly important that we assess the human and social effects of decisions involving technology, and almost all public policy issues do today. This situation requires a new and increased level of technological literacy among the general public if they are to exert their proper influence on the course of events. Also, system experiments must be used as an adjunct to paper assessments of technological influences. These requirements call for a new synthesis of educational values so that technological literacy can join the traditional objectives of the cultural curriculum.

WORLD FOOD PRODUCTION POTENTIAL

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WITH the approach of a new century, the year 2000 has become a popular benchmark for predictions of various kinds about the human condition. Many of these can be placed in the category of science fiction. However, one of the more apparently fantastic of these exercises, in truth, is deadly serious.

Basing its projections on the present rate of growth, the United Nations predicts that the population of the world will double by the year 2000—giving us more than six billion human mouths to feed. When the projections are carried beyond the year 2000, they enter the realm of the fantastic and, if carried to the extreme, would show the world literally awash with humanity. Obviously, this cannot happen. At some point, the projections take leave of reality. But reality alone is enough to give thoughtful persons cause for concern.

Those who take an extremely pessimistic view, despair for man's survival on this planet, predicting famine, war, and ultimate catastrophe.

The situation often is characterized as a grim race between population and food supply. Odds are given that population will "win," far outstripping the world's ability to produce the necessary sustenance.

However, there is great irony in these gloomy predictions. Population is increasing so rapidly precisely because more food is being produced than ever before—a seemingly happy circumstance.

The rhetorical question, "Will the world be able to feed its people by the year 2000?" is wrongly put. We must conclude that those people who are alive will be fed. One cannot live on nonexistent food. When the United Nations projects a world population of more than six billion by the year 2000, this is based on the necessary assumption that there will be food for that many people.

The race between population and food supply must invariably end in a tie. When food is abundant, it is somehow refined to fit the existing number of human stomachs. When it is scarce, the supply is stretched to cover the need. When the supply has been stretched as far as it will go and there still is not enough food to go around, the human population is reduced proportionately. This leveling process is continuous and does not wait or save up until any distant target year.

We rather callously summarize the miseries of the world in this equation. Indeed, what we truly consider, when we attempt to project population in relation to food supply, is the quality of human life. The Bible and other chronicles of mankind are replete with accounts of feast and famine. This has been the essence of the human condition since recorded history. Thomas Malthus, in 1798, first defined the problem in an academic sense. He concluded that war, famine, and pestilence would inevitably bring population into balance with food supply. This was the law of nature, and throughout history only a fortunate few have escaped its vicissitudes. Some of the population has been hungry all of the time, and all of the population has been hungry some of the time.

Malthus was convinced that only through sexual constraint could mankind rise above his miseries. His argument has familiar echoes in our own time. But for the most part during the past century Malthusian theory was felt to be out of date. The industrial revolution in the Western nations of Europe and in the United States—based on an underlying revolution in agriculture—gave us cause to believe that technology could permit man to outrun his miseries.

Following World War II, widespread application of public health measures and modern medicine caused death rates to drop in many developing nations, without a corresponding decline in birth rates. As a result, world agriculture was handed additional

burdens of feeding rapidly expanding populations, and a growing wave of pessimism has tended to revive the Malthusian theme. Sexual constraint—under more modern and sophisticated guises of population and birth control—is again seen as the only hope.

Without succumbing to extreme pessimism, it is evident that world population *is* spiraling upward, and great difficulty *is* being experienced with providing adequate food supplies in many regions of the world. Even if birth rates could be brought sharply under control through some currently unknown means, the need for food would continue to increase rapidly for many years.

In many areas of the world, forty percent of the population is fourteen years of age or younger. Their appetites will grow as they reach adulthood. Modern medicine will tend to prolong their lives, and as they reach childbearing age—even if birth rates are reduced—many new children will be born. Given these conditions, we cannot doubt that hunger is a real specter for much of the world and that agriculture's capability to meet the challenge will be rigorously tested.

But a principal point of my address today is to add the element of hope to this otherwise glum scene. I do not believe we can afford to sink into a morass of pessimism. Hope is the necessary yeast of human striving. And strive we must, if we are to succeed in our race against the Malthusian scourges at this critical turning point in history. Therefore, I wish to bring to your attention a new revolution which is occurring in parts of the developing world which may augur advances in the human condition as significant as those brought to the Western world by the industrial revolution.

I am referring to a *new* revolution in agriculture which is beginning to take place in far-flung regions. In India and Pakistan, in Ceylon and the Philippines, in Mexico and in the Gold Coast of Africa, agriculturalists already are speaking of a new era of agricultural abundance. The sources of my information stem from my participation during the past two years in four major programs whose purpose was to develop the best information available on which to assess man's ability to meet his present and future food needs.

These programs were: the report of the President's Science Advisory Committee Panel on World Food Supply, in which more

than one hundred outstanding scientists, technologists, and businessmen were involved; a symposium on "Food for Billions," sponsored by the American Society of Agronomy; the Thirty-fourth American Assembly, a gathering of sixty national leaders in the scientific, educational, and business communities to discuss "Overcoming World Hunger"; and the agricultural symposium that I arranged for the American Association for the Advancement of Science at its annual meeting last December, at which experts from around the world discussed "Research for the World Food Crisis."

Out of these meetings with experts from this country and abroad, many of whom are responsible in one fashion or another for the advances being made, and from references to numerous reports by national and international agencies concerned with food production, and from references to many monographs, papers, and publications, I have gleaned the information which I report to you today.

Most of us understand the concept of expanding food production to mean simply increasing total output from the present mix of crops and livestock. This is what usually is meant when we talk of producing more food. However, not so well understood are the potentials that come from "adjusting" the mix of inputs and outputs.

A highly effective adjustment potential exists, for instance, in livestock production. It is possible to feed seven times as many people on crops consumed directly as it is on crops first consumed by livestock and then converted into meat, milk, and eggs. If the food supply is reduced (or the population increased without corresponding increase of food supply) we can eat the livestock and then eat the crops the livestock would have eaten. The potential is enormous, but not all countries have this shock absorber.

The United States has a large livestock population. If we were willing to accept a diet similar to that available to most people on earth, we could easily feed several times our present population on the same acreage. But some countries have long been so near the margin of want that the livestock population is very small and there is little cushion from this means to avert disaster.

Another great adjustment potential exists in the intensification of cropping systems. In the United States, potatoes, rice, and corn produce almost twice as many calories per acre as wheat. Rye produces only half as much. Among the vegetables, carrots yield twice as much as wheat, while beets and celery yield about the same as wheat, and so on. These ratios will vary from country to country and from year to year. Gradually, over time, a cropping system emerges which takes into account agricultural resources, population density, food preferences, nutritive needs, and the state of technology. If food becomes more abundant, a country shifts away from the crops that produce large amounts of food. If the population presses heavily on the food supply, the cropping system is intensified.

Two other areas of adjustment are stocks of food and trade. Stored-up food supplies are useful in the short run, but can have little significance with regard to feeding vastly increased population. Stocks are a short-run shock absorber. On the other hand, trade is important both in the short run and the long run. If one part of the world has comparative advantage in agriculture and some other part in industry, exports can help adjust the food supply to the population in both areas.

Technology also may be considered as an adjuster, in the sense that people move to adopt alternatives in food consumption which are provided by technology. As examples, spun protein, made from soybeans, provides a meat substitute, nutritionally equivalent to hamburger, at about half the cost. Also, butterfat costs about seventy cents a pound, while soybean oil costs about ten cents. Food can be fortified with low-cost nutrients. Man-made fibers are replacing cotton and wool, releasing acreage for food production. As internal combustion engines replace animal power, vast acreages are released from feed production for the production of human food. Many more examples of technology as adjusters of food supplies might be given. Many have been developed within recent years, and we can expect many more in the thirty years between now and the turn of the century.

But how important are these "adjusters"? How much flexibility do they provide? I must conclude from recent history they are very important and provide more flexibility than commonly is as-

sumed. Because of new technology, they have grown important enough that, during the recent disastrous crop years in India, widespread famine was averted. Western Europe was able to avoid mass starvation during World War II, despite the cut-off of food imports and the diversion of manpower and production to war. The United States has upgraded its diet sharply during the past quarter century, while reducing agricultural acreage.

There is enough flexibility in the world's existing food supply system so that any projections of existing production patterns, existing diets, and existing rates of population growth, with the inevitable prediction of food shortages, are bound to be wrong.

But as important as these adjustments and technological innovations are—and will continue to be—they are not the primary engines of revolutionary change of which I speak. In the larger developing countries of free Asia, we are witnessing the onset of a new era in agriculture which is characterized by explosive increases in production of principal cereal crops.

The 1968 Pakistan wheat harvest was up thirty-seven percent over that nation's previous record, possibly an increase without precedent in any major country. India's wheat crop last year was up thirty-five percent over the previous record year; its total food grain harvest was up twelve percent. Ceylon's rice crop has increased thirty-four percent during the past two years. The Philippines, with two consecutive dramatic gains in its rice crop, has apparently ended half a century of dependence on rice imports.

Favorable weather contributed to the record harvests in some of these countries, but that is only one factor. These nations are now achieving increases in yield per acre comparable to those achieved in the developed Western nations during the first half of this century. While Asia has experienced the most rapid advances, Mexico in Latin America and Kenya and the Ivory Coast in Africa also are beginning to enjoy the fruits of modern agricultural technology, and the improvements can be expected to spread throughout the less-developed world during the next several years.

This new era in world agriculture promises to be dynamic, providing new opportunities for farm families. Hundreds of millions of persons who heretofore have eked out a subsistence living, consuming all they produce, could be brought into the marketplace.

The result would be a broadened economic base within individual developing countries, greatly enhancing their prospects for industrial development.

The agricultural revolution which now appears to be under way is much more than just the conventional formula of using improved seeds, fertilizers, pesticides, and more water. New cereal varieties which have been developed through research in experiment stations in tropical and subtropical zones are rapidly spreading to crop production in many lands. They are not just marginally better than traditional grains; they are dramatically superior, frequently doubling yields under field conditions. They may be to the agricultural revolution in the less-developed world what the steam engine was to the industrial revolution in Europe.

Let us examine some of the sources of the increases in production which are taking place.

1. The new grain varieties respond to much heavier applications of fertilizer and use it more efficiently. If one pound of nitrogen fertilizer applied to the old varieties resulted in ten pounds of additional grain production, a pound applied to the new varieties may result in fifteen, or as much as twenty-five, pounds of grain under favorable circumstances.

2. The new varieties, unlike most of the traditional grains, are not very sensitive to the length of the day; therefore, they can be planted any time of the year in most of the tropics and subtropics where the water supply permits.

3. The new varieties are early maturing. In the case of rice, 120 days are required for maturity, as contrasted with 150 to 180 days for traditional varieties.

4. The practice of planting more than one crop during the year—called multiple cropping—is increasing. The possibility of planting year round, plus the earlier maturity of the new grains, permits an increase in double, or even triple, cropping. Farmers in India, Indonesia, and the Philippines are now double cropping rice and, in some instances, even triple cropping where water supplies are adequate. Where water supplies are not adequate for grain during the dry season, farmers are beginning to plant high-yielding grain sorghums. Some farmers are able to plant a third crop, such as potatoes, or a protein crop like beans.

5. Mechanization also is increasing food production. Full use of the new technologies requires much greater inputs of labor in more careful planting, continuous weeding, frequent irrigation, and the harvesting of much larger crops. In some rural areas of Asia, seasonal labor shortages are becoming common. Further mechanization will permit better seedbed preparation and will enable farmers to realize more fully the full genetic potential of the new varieties. The possibility of continuous cropping throughout the year places a premium on rapid, mechanized harvesting and seedbed preparation.

6. The use of water, like fertilizer and other inputs, also is rising steadily. The prospect of growing the new varieties throughout the year means that the value of water has increased sharply. Farmers throughout Asia are investing heavily in tubewells and pumps to lift water into their fields from underground sources or from low-flowing rivers and canals during dry seasons.

These are only a few of the principal sources of food-production increase associated with the new varieties, but they help illustrate the dynamics of the change which is taking place. However, we must understand that the revolution is only beginning. Great efforts will be required. The engines of change are the new varieties of grains. But a near doubling of the historic rates of growth in all food production will be necessary for the developing nations to break their dependence on food aid from the developed nations, to reach minimal levels of food consumption over the next decade, and to achieve higher rates of economic growth.

To achieve this additional rate of increase—from the present two percent average to about four percent annually—will require unprecedented rates of change in resource commitments. It will require massive efforts by many developing countries and considerable assistance from the developed nations.

Improved rates in food-production growth in less-developed countries will depend on their will and ability to take needed steps. It will require large increases of inputs, such as improved seed, fertilizer, water, pesticides, machinery, and land; it will require large step-ups in public and private investment in research and in training of extension personnel to get the improved grains into produc-

tivity; it will require much greater investments in marketing, storage, and transportation systems to support desired increases.

As agriculture begins to advance rapidly, many "second generation" problems are created. Typically, these are political, social, and economic, rather than strictly agricultural. But they illustrate the breadth of research and development required to accommodate increased agricultural production.

Farm credit and government price supports are among these second generation problems which are quickly coming into focus. The larger farmers—usually well situated financially—are typically the first to use new production practices. But unless an effective system of farm credit is instituted, the smaller farmers may, in effect, be denied access to the new technologies. Furthermore, as production surges ahead, market prices begin to drop, and governments may be hard pressed to maintain price supports. They must also wrestle with the problem of support for internal price levels in relationship to world market prices.

Another problem is that the new varieties of cereals are frequently unfamiliar to consumer tastes and are discounted in the marketplace. Over time, the discount usually diminishes as consumer tastes adjust to the new varieties or breeding efforts alter them to suit local preferences.

As new agricultural technologies are adopted, their benefits are not evenly distributed. Those farmers with the more fertile soils and the more reliable year-round water supplies will stand to benefit most. The economic gap between the better farms and farmers and the more marginal ones is almost certain to widen—as it has in the United States during the past fifty years.

There is yet another special problem in the developing nations which will make the agricultural revolution there more difficult to achieve than it was in the Western nations at the turn of this century. The agricultural revolution in the West was facilitated because industrialization was already in process. As agriculture became more productive, rural people left their farms and went to the cities for available industrial jobs. The reduced rural population permitted those who remained in farming to operate larger, more efficient farms.

But the less-developed countries are not industrialized, and jobs are not available. As a result, the growing population is likely to concentrate on farms which are already too small. The average farmer in the developed countries today has about four times as much land as the farmer in the less-developed countries. By the year 2000, he can expect to have fifteen times as much—a situation explosive politically as well as troublesome economically.

Another great disparity between the developed nations and the less-developed nations is in agricultural research. The Rockefeller Foundation recognized this back in the 1940's and established a wheat-breeding program in Mexico. The Rockefeller and Ford Foundations combined resources in 1962 to establish the International Rice Research Institute in the Philippines. The earlier success with wheat in Mexico and the relatively quick and dramatic pay-offs in rice breeding have awakened widespread interest in agricultural research in the developing countries.

Today, the work in Mexico is being carried out under the Rockefeller- and Ford-sponsored International Maize and Wheat Improvement Center at Chapingo. Two additional centers are being organized by the two foundations. These are the International Center for Tropical Agriculture in Colombia and the International Institute for Tropical Agriculture in Nigeria. Rather than concentrate on particular crops, they will work on tropical agriculture more broadly.

The return to society from investment in these research centers has been phenomenal. The cost of establishing and funding the International Rice Research Institute has totaled some $15 million to date. The value of additional rice production resulting from the spread of new rice varieties and improved practices is already in the hundreds of millions of dollars. Within the next several years it could total several billion dollars, but perhaps the more significant long-term contribution of these projects will be the support they engender for agricultural research in developing countries.

It would be disastrous to assume that these new high-yield grain technologies now provide a sufficient answer to the needs for increased food production. Without heavy application of additional resources to research in the developing nations, we may already have seen the major impact which can be attained by these

presently available improved varieties. So far, with current production technology, these varieties are capable of causing spectacular production increases on only a fraction of the land on which wheat, rice, and maize may be grown in the tropics and subtropics. If increases in productivity of the magnitude experienced to date are to be extended to the many millions of acres where striking results have not yet been achieved, new break-throughs in technology based on extensive research programs will be required.

There are also many other crops which could make large contributions to the total food needs of the tropical and subtropical lands. These include, for example, the root, grain, legume, and vegetable crops which have not yet had the benefit of improved technologies. Vast areas of the tropics are potentially arable, but as yet are unused for food production, except in extremely primitive fashion. The technologies of modern agriculture have not yet been developed for these areas.

Plant pests—including insects, diseases, nematodes, weeds, and often mammals and birds—take an extremely heavy toll of crop production in the tropics and subtropics. Extensive research efforts will be required for the development of adequate controls for these areas.

Furthermore, continuous intensive agricultural research is required to maintain the advances made through previous research programs. We know, for instance, that new diseases and insect pests may develop which are capable of striking down the resistant varieties now being used. We must view with concern the fact that millions of acres of wheat and rice are being planted in Pakistan and India and other countries to one or a small number of varieties of each crop.

In addition to efforts to sustain and to increase productivity per acre, we must also turn our attention to the quality of the crops produced. Deficiencies in quantity and quality of protein have a devastating effect on both physical and mental development of people who live on the predominantly starchy diet of the cereal grains and the root crops. Encouraging new developments in quality protein production by the cereal grains suggest the possibilities for vast improvements in nutrition with adequate research.

Protein malnutrition is a severe, debilitating force in the tropics and subtropics, affecting hundreds of millions of people, particularly infants and growing children. This deficiency exacts a heavy human toll in terms of suffering and a heavy economic toll in terms of underdeveloped and wasted human resources.

The United States AID Mission in Brazil has made a study which illustrates the economic loss to a society where people are not effectively developed as a resource. Taking a million persons at birth in three separate locations—northeast Brazil, the Sao Paulo area, and the United States—the study points out that, after adjusting for life expectancy and literacy:

- The million people born into northeast Brazil contribute only 12 million adult-literate man years to society;
- Those born into the Sao Paulo area contribute 25 million;
- And those born in the United States contribute 48 million;

a four-fold variation between the lowest and the highest.

Not taken into account are the differences in quality and productivity of adult-literate man years contributed, which may be even greater than the variation in man years.

It is evident that research efforts will be required throughout the developing world comparable in scope and magnitude to those that have provided the technological undergirding for agricultural abundance in the United States and other developed countries. But these efforts must be carried out on a very much shortened time scale. Organized agricultural research had been carried on in the United States for three-quarters of a century before substantial increases in productivity began to occur in the early 1940s.

If we had a century, or even fifty years, in which to win the race with hunger, it could be accomplished by the establishment of national and local institutions, country by country, area by area, to train the required numbers of scientists, teachers, extension workers, and other agricultural specialists in conventional academic programs and to carry on the research required for developing the necessary technologies. This was the means by which the revolution in agriculture was achieved in the United States.

Unfortunately, a century, or even fifty years, is not available. The race of food supplies against population will have been lost irretrievably long before that time.

It is generally conceded that the greatest immediate gains in food production are to be realized by more intensive cropping of existing cultivated lands. During the past century, vast new production came about by adding new lands to the arable acreage. But this method of gaining food production requires greater outlays of investment, under present technology, for the short run.

The possibilities of opening up new lands to cultivation through adaptation of nuclear energy to sea water desalinization holds great prospects for arid regions adjacent to the world's oceans. However, since this involves mass migration of population to these areas as well as large capital investments, for the most part, its realization as a means of impacting world food supply is some time off.

Also, much consideration is being given to means of increasing the catch of fish and other, more exotic, kinds of ocean harvests. Some experts estimate that the fish catch could be increased two to threefold, without depleting stocks. However, much of the world's population lives far from large bodies of water, and the mere landing of fish from the sea does not ensure its consumption. This very perishable commodity must be moved through distribution channels to the consumer to reach him in an acceptable condition and at a low enough cost.

Developing countries with access to the sea have begun to solve these problems, and ocean catches have doubled in the past decade. It is estimated that about sixty-three percent of the catch is used as human food, and most of the remainder is used as animal fodder, mainly in already well-fed countries. By grinding and solvent extraction, much of this fodder fish can be turned into an edible, high-protein product for supplementary human consumption. However, much additional research and development, particularly on the means of distribution and consumer acceptance, needs to be done before this will become a major new source of world food supply. This also is the case with algae farming and other potential sources of food from the sea.

The foregoing fairly well covers most of the major technological considerations involved in the new hope which is being expressed by many agriculturalists and scientists for the world's ability to feed itself until the turn of the century.

I should like to add one other factor which I believe augurs well on the side of more adequate food supplies. And this is the discovery, from our recent experience, of the errors of some of our previous concepts.

During the past quarter century, efforts to transform the traditional agriculture of the developing countries produced little results. Yields per acre remained static. Will M. Myers, vice president of the Rockefeller Foundation, summarized the reasons for this in his overview address to the agriculture section of the AAAS annual meeting in December.

"It now becomes clear," he said, "that at least three major misconceptions on the part of those concerned with agricultural development were largely responsible for the lack of progress." These were:

1. That it would not be necessary for the developing countries to go through the slow process of agricultural development; instead, they could leapfrog over this step and embark straight away on industrial development. Because it was believed that agricultural development was not a necessary step in economic development, foreign assistance agencies emphasized industrial development, education, and other aspects, while providing relatively little assistance for agricultural development.

Such policies were disastrous. Masses of the rural population did not participate in development; they remained essentially outside of the economic mainstream. Precious foreign exchange was required for food imports. Little or no internal savings could be generated by a largely subsistence agriculture. Industrial and other economic development could not occur without development in the agricultural sector.

2. It was assumed that there were a dozen or more prerequisites to agricultural development, all of which had to be in place at the same time. Thus, the limited resources committed to agriculture were dispersed over a broad spectrum of activities. These included establishment of agricultural extension services and rural credit agencies, building farm-to-market roads, developing marketing facilities, building storage and transportation facilities, establishing marketing standards, and so forth.

But the extension services failed because they had nothing to extend. Farmers were reluctant to borrow for purchases that would not strikingly increase yields. Marketing facilities were useless without products to market. Storage facilities stood idle. We had done everything except to provide the farmers with the capabilities of increasing their yields.

Fortunately, events of the past two years have shown that very rapid agricultural development can be triggered by providing only a few critical things. In most parts of the developing world, these critical things are adequate technologies of production and adequate numbers of trained people.

3. The third and most monumental misconception of all was that technologies of production in agriculture were transferable from the United States to the underdeveloped nations. It was assumed that it was simply necessary to take the improved varieties, fertilizer practices, disease- and insect-control methods, and other technologies of production to the underdeveloped countries and put them to use.

This misconception was probably more responsible than anything else for holding back modernization of traditional agriculture. We have since realized that the technologies of agricultural production developed in, and adapted to, the temperate zones of the advanced nations were simply not adaptable to the tropics and subtropics of the underdeveloped world. Indeed, we had long known in the United States that technologies of agriculture tend to be nontransferable. But, somehow, we forgot this experience when we turned our attention overseas.

As a result of the recent, dramatic experiences with wheat, rice, and maize in the developing countries, it is possible to outline, in broad terms, a strategy of agricultural development which will enable the developing countries to keep up for at least the next couple of decades with increases in food demand.

Again, Myers provides us with the five major components of this strategy.

1. The leadership of the developing countries must want agricultural development seriously enough to allocate the required human and other capital resources to it and to develop domestic

policies which make increased agricultural production profitable to the farmers.

2. Adequate technologies of production must be available, or developed, and they must be capable of causing very substantial increases in yield per acre. The traditional farmer who lives on the narrow margin between bare subsistence and starvation cannot afford the risks involved in adopting new practices which promise no more than 10, 15, or 25 percent increases in yield and particularly when it is not even certain that a decrease in yield will not result.

3. Very large numbers of people must be provided with relevant training to enable them to perform effectively in research, education, extension, and other agricultural programs required for agricultural development.

4. Arrangements must be made to ensure that farmers have available to them, on a timely basis, the purchased inputs which are required as a part of the package of production practices.

5. Sharply focused programs, having realistic goals, must be developed in each country and must become part of the official policy of the country.

These circumstances of incipient revolution in world agricultural production which I have described, combined with the strategies of action for the future, which I have outlined, give us hope for the first time in history that mankind can adequately feed itself.

It seems certain that the technologies presently in existence make it possible at least to stave off the prospects of widespread famine until the turn of the century, if only the effort is made.

Equally certain, it appears, is the urgency to use this "borrowed time" to develop similar strategies to slow, and ultimately check, world population growth.

It is my own belief that the attendant social changes which are bound to occur as a result of the agricultural revolution itself will help to moderate the upsurge of population growth. But I believe that concerted programs of population control must also be developed and implemented as soon as possible.

Thus, we see that the question with which we began—"Can man adequately feed himself at the beginning of the 21st century?"—is no longer proper. The proper question now is only: "Will he?"

Charter Day Lectures

A LOOK AT THE NEXT 100 YEARS

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IN talking about the next 100 years, we must examine the important principles of the last century which set the courses of the land-grant institutions—serving the people by low cost education, serving the people by applied and practical as well as theoretical research, serving the people by providing a spirit of freedom. These traditions will remain important to our universities in the next 100 years. This university and mine were among the first land-grant institutions. As we face the second century of the land-grant movement the University of Wisconsin and Oregon State University are pioneer Sea Grant universities. (The University of Wisconsin is not located on an ocean, but we are located on something very much like an ocean, the Great Lakes, and we can pollute the Great Lakes faster than you can the oceans; perhaps that is why we are in the sea-grant business, too.)

The land grant, the sea grant, and the urban grants which are coming, all continue the traditions of education for the many, practical as well as theoretical research, and education in the spirit of freedom. Thus, in many respects, the next 100 years will be like the last century.

One of my teachers at Cornell University, one of the great historians of this century, Carl Becker, wrote a book just as World War II was ending. In those days a great many people felt that, with the defeat of Hitler, everything would be perfect in the future and we could all look forward to a much better world. So Carl Becker, who was old and wise, wrote a book called *How New Will*

the Better World Be? His message was that although the defeat of Hitler was a good thing, it was not likely that it would change mankind. It was very likely, he predicted, that the forces of nationalism, imperialism, national conflict, selfishness of man—as well as the force of man's aspirations—would rule.

The book was badly reviewed. Critics said Becker has become so old that he does not realize that we can improve the world. Truth is, he did make some mistakes. He underestimated the possibilities of the developing nations—the way in which we did get rid of a good deal of the old-fashioned imperialism—and set a number of nations on their way towards democracy and higher living standards. But he was right in thinking that the past has a great deal to do with the future.

The interpretation of his book, of course, was so forlorn because the expectations of most of us were so high. When he was realistic many of us were disappointed.

Compared with 1944, our expectations are not high enough. Our expectations for the future are unpleasantly, rather than pleasantly discouraging, or at most, quietly hopeful rather than enthusiastically so.

When I began this talk I said that the next century would be, in many respects, like the last one. That's another way of saying that it will be very good, because the history of this institution is a noble history and a great portent for its future.

We are heavily pressed on the tax front now. The states are having major financial difficulties because, with the continuation of the Viet Nam war, the federal government is not about to share taxes with the states, nor is it about to give institutional grants to colleges and universities. It ultimately will for the nation must share the extra burden which the next decade will provide.

Currently we are in something of a crisis in our tradition of low-cost education. Yet, it is of enormous importance that we, in the next decade, the next generation, the next century, hold to this point—low fees, low tuition, opportunity for the poor.

When the land-grant system was established in Abraham Lincoln's day it provided federal support for state universities in every state. The purpose was to make higher education available to the poor people of that day—the mechanics and the small

farmers. That has been central, in our academic plans since. We have slipped a little bit in this respect of late. The statistics unfortunately show that if your family is in the top quarter of the income brackets, you are about twice or three times as likely to go to college as if your family is in the bottom quarter. We can lay most of the blame for this to charging more for higher education and pricing some people out of higher education. We'll have to see to it that this trend does not continue—that it is reversed—for low-cost education means a great deal to our democracy and to our culture.

The twin tradition to low-cost education is practical education. As you look at the history of this institution as described in the essay published for this occasion, you can see that the practical education theme was exceedingly important in the early days. In recent years, universities like Oregon State have developed graduate work of highest quality, a great deal of it theoretical. Fundamental research, pure research, basic research, is, of course, the research that will make possible the gains of the next generation, the next four generations, the next century. We welcome this theoretical, basic research. We are very proud of it. But at the same time, we must recognize that our tradition is not only in basic research, but also in its applications. This university, with its Cooperative Extension history has recognized this very well. It is not enough to make the breakthrough, you know. It is necessary to apply fundamental research findings to the improvement of the average man whether he is a farmer or employed in industry, the service trades, or whatever.

All of us who are in the land-grant institutions and some in other institutions, both private and public, are paying increasing attention to action programs, to problem solving, to helping industry, to working overseas.

That's practical, that's application, rather than theoretical. That's the extension movement, that's public service. It is the kind of thing that made our reputation and which we should not cast aside just because we are becoming distinguished in the theoretical research.

Another tradition of our last century, important to us today, is our freedom tradition. If we are to continue to improve our na-

tion, views of all sorts should be expressed on our campuses. This is the hardest thing of all for some people to understand. It is easy enough for them to listen to something with which they agree, but it is difficult for them to understand why they must also listen to views that are repugnant. But we must listen to all views because we cannot progress without giving a hearing to new views. A politician in my state, in the campaign this fall, said his definition of academic freedom was that professors and speakers could express different views with but one qualification: they must be *good* views.

We probably are facing a period in which minority views will become increasingly unpopular. The cry for law and order is quite understandable in view of the difficulties we have been facing on our campuses and in our cities, not only understandable but in many respects quite correct. We cannot allow dissent to go to anarchy; we cannot permit demonstrations to proceed to disruption; we must not permit violence in the expression of dissenting views; we cannot permit those persons who do not like free speech to shout down speakers. The right to speak is the right to listen, too.

We are at something of a crossroads here. We must beware, we must watch out, when we take care of disruption which we cannot permit, obstruction which we cannot allow. We must be careful that we do not, in the process, destroy other freedoms which are fundamental and without which the American campus would have little meaning.

The university for the people with its practical as well as its theoretical side can be understood only in the context of freedom —freedom sometimes beyond the point of comfort. We managed in the past, we must do as well in the future.

Many things will change in the American university. It is certain, for example, that the student will have more to say in the future than they have had in the past. Students are more mature now than before—better educated, for example, than we were when we went to college. It may not always seem so to older people, but we should not confuse youthful foolishness with stupidity. The young people are bright, they are imaginative. We have to get up quite early in the morning to prepare for days in which the students have a special interest. But students also have a great

deal to offer, and it is entirely clear that they will be participating much more on the curriculum front, in development, in conduct enforcement, and in advising in the future. This is good, and curiously enough it fits in with most of the other traditions of the land-grant institutions.

Activist students are talking about involvement, about commitment. This is in our tradition. We have been involved in promoting agriculture, in promoting the maritime sciences, in developing better cities.

Obviously, the students are not altogether to be praised. They have damaged some institutions seriously, and this is the predominant public view of them. Few give the activist students credit for interesting other students in politics, interesting professors in undergraduate instruction. Thus we must defend these students for what they have accomplished, even while we are criticizing them for bad taste, bad judgment, bad tactics, and a variety of other things we think are bad.

The next century is going to see many other changes in the university. We can expect that the line between secondary school and the university will fade. We can expect, in the next few generations, that when they come to the university, many students will be ready for the third year of the university rather than the first. The improvement in secondary schools throughout our country in the past few years has been so dramatic that we in higher education must admit that improvement at that level is probably greater than the improvement in higher education. There will be more educational improvement in the future and we will be ready for the students it produces.

As the lines between the secondary schools and the university become blurred, so will the lines between the university and the rest of life. Because knowledge now becomes outdated overnight, life-long learning obviously is a necessity. In consequence, the next century is certainly going to see an enormous, an incredible increase in adult education, noncredit adult education, conferences, workshops, institutes, radio and television education, correspondence education. In the process, it seems likely that, while the campus will continue to exist, it will lose some of its current importance.

When life-long learning becomes established as a necessity (it is now but not yet fully recognized as such), when life-long learning becomes understood to be our way of life, obviously the campus will be the city, the campus will be the country, the campus will be everywhere. And we will be moving into a period in which the undergraduate years and the graduate or professional years are hardly distinguishable from the rest of life.

Along with this, I am sure, will come a blurring of our state and national lines so that the old tendency to think in terms of the state and the nation will give way to the international spirit which already is strong among young people. It soon will be as strong with us all.

All of this will make for a very busy future, a very confused future, a future that will have its regrettable incidents, perhaps even its regrettable decades. It is absolutely impossible to look at the last century, to see what has happened to this land of ours in 100 years, without having a good measure of optimism, for the future. We are just beginning—just beginning.

An English literary critic who chose to write a book about Thomas Wolfe found she had great difficulty in explaining why he seemed not really to have grown up either in his life or in his writing, why he seemed to be just getting formed when he died. She concluded her book with this statement:

"After all, he's an American, and you must understand that in America the people are about in the age of Chaucer and that the future lies before them."

I don't suppose she meant that altogether as a compliment, but it comes pretty close to a hopeful prediction for us. If we are in the age of Chaucer, there are many good days ahead, and this university will help to create them.

THE LAND-GRANT IDEA AS A WORKING PROCESS:
The Search for the Relevant Education

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TODAY we hear around us grave and sincere suggestions that the modern university is losing its identity and its integrity; that it has become uncertain of its purposes, confused by the babble of the market place, fearful that its processes are no longer manageable, the victim of its very effectiveness which is forcing the proliferation of its activities. We also hear strident voices charging that the university is losing its usefulness and its viability as a social institution. We hear discordant voices calling for its radical restructuring.

All of us who are concerned with higher education realize that the land-grant universities are in the midst of accelerating forces for growth and change. Old pressures for change are being magnified; new coercions are being created daily. Perhaps, however, when we are plagued with self-doubts concerning the future of our universities, we might ask ourselves "Was it not always so?" Have thinking persons concerned with education ever been clear and secure in the direction and course the land-grant university was taking in their own particular period? Indeed, has there ever been a time in the development of the land-grant institutions when they were sure of their identity, certain in their purposes, confident of the efficacy of their processes?

I do not ask these questions in any spirit of antiquarianism. Nor do I ask them in an effort to adopt the comfortable philosophy that because we have lived through hard times once, we can certainly manage to get through them again. Nor are these questions

based upon any misery-loves-company psychology. Rather, I ask them because I believe that in their answer lies the key to why the land-grant university, an institution which had its beginning in a rural, agricultural America, has been so remarkably effective in meeting the radically changing and growing educational needs of the highly complex scientific and technological, industrialized and urbanized, society which is America today.

I would like to consider the land-grant university not as an institution which has been built, as we sometimes seem to believe, on a single educational concept—upon the concept which has come to be known as the "Land-Grant Idea." Rather I would like to view it as an institution having its origins within a whole budget of diverse and sometimes conflicting and antagonistic educational ideas, which over the years the land-grant institutions have had to balance out, reconcile, integrate into a workable educational synthesis.

Someone has observed that during all of the hundreds of years in which the university, as a social institution, has been developing out of its medieval past and taking on its modern form and function, there have been a remarkably few institutions which have been built upon that rarity in higher education, a new and different idea.

The land-grant institution, however, is generally singled out as one of those rare institutions which was built upon a new idea. In fact, as we look back across the span of a hundred years of land-grant university development. I think we sometimes tend to view the land-grant concept as a single, quite fully developed, and completely original idea which suddenly made its appearance on the American scene in 1862.

This rather simplistic assessment of the land-grant concept, however, puts me in mind of Voltaire's famous epigrammatic comment on the Holy Romen Empire. "This agglomeration which calls itself the Holy Roman Empire," he said, "is neither holy, nor Roman, nor an Empire." The agglomeration of educational purposes and philosophies which were brought together in what we call the land-grant idea was neither new, nor fully developed, nor a single idea. Indeed, a good case could be made that the land-grant idea was not an idea at all, but rather a self-generating evo-

lutionary process, which out of a progression of competing and even conflicting ideas has been developing and is continuing to develop a moving and changing concept of education which meets the imperatives of a changing society.

The land-grant concept, as it emerged from the halls of Congress in 1862, was truly the product of the raw materials of a young, growing, and stretching American democracy. It was a direct response to the new stirrings and quickening of American democracy as it emerged out of the constrictions of the federalist period into a Jeffersonian and Jacksonian America. It reflected an awakening to new democratic values, new humanitarian ideals and new concepts of social equality which were arousing the conscience of pre-Civil War America. It was the product of a democratic optimism, of the rising expectations of those who believed that the good things in life which an undeveloped and unexploited continent were promising should be shared by all. It represented confidence in the efficacy of education as the agent of progress. Above all it reflected the growing class consciousness of the farmer and labor groups and the growing democratic belief that higher education should be one of the benefits of society which should not be the exclusive property of an aristocracy of wealth or privilege but was a right which should be shared equally by all.

Perhaps, then, if the land-grant concept had any one central idea, it was the belief that the new land-grant institutions were to be "democracy's colleges." Perhaps the only new, the only fixed and certain idea within the land-grant concept was the understanding that the institutions which were being created were to have a covenant with democracy, a responsibility for providing the kind of education which would be relevant to the purposes, the needs, and the interests of not just the few, but the many.

The land-grant concept was also the product of democracy in that it was part and parcel of the whole "blooming, buzzing confusion" of the educational views, opinions, ideas, purposes and philosophies of a young and raw society which was looking for new answers to the question of what comprised the relevant education in a democracy. These ideas ranged from the old and restrictive dogmas of the traditional education of colonial America to the new free-wheeling thoughts about a new kind of experi-

mental, laboratory-based science, the need for vocationalism in education, and even plans for taking education out to where the people worked and lived. Thus the land-grant concept was the product of a kind of gathering up and wrapping into one bundle of all the educational ideas which were at hand.

The land-grant concept, as it was written into the Morrill Act, was the product of that kind of democratic compromise which is little more than a political log-rolling process in which each interest is given all that it wants. All views, however diverse, inconsistent, and even conflicting, were simply added together. To gain the political support which would ensure its passage by the Congress, it was designed to mean all things to all men. It deliberately took account of and reflected the whole spectrum of prevailing opinion on educational needs and purposes. As President Scott of Ohio frankly stated in his inaugural address in 1884: "It does not require a very close scrutiny of this language to discover that it is not the statement of a single mind setting forth a single untrammeled purpose. It is the welding of two opposite views. . . . The result was a compromise—a compromise which consisted not in abandoning the extremes for intermediate ground, but in a union of the extremes."

The land-grant concept brought together, but did not reconcile, two quite distinct and even competing and antagonistic strains in educational philosophy, two conflicting views concerning the nature and purpose of education. They were educational philosophies which gave conflicting answers to the large central question: "How should higher education function within its society? What, in short, was the relevant education?"

The first strain was made up of a compromise of ideas which might be loosely described as being built around a philosophy of the "separativeness" of higher education from its society; the second, around the concept of the "involvement" of higher education in the society of which it is a part. Both of these philosophical strains were still inchoate and undeveloped in 1862. Many of the ideas which have become important to each concept were, as yet, still only partly formed. Many important elements of each were still missing and had yet to be invented. Old ideas were still tied into new and radical proposals for educational reform. Neverthe-

less, out of the agglomeration of vague and confused ideas and notions which made up the land-grant concept of 1862, the two separate strains in educational philosophy—that of separativeness and involvement—were already emerging. Each had its own understanding of how society could best be served through higher education. Although they shared many common values, and perhaps their value systems differed more in degree and tone than in kind, each had its own distinct pattern of values. Their vague beginnings were already foreshadowing the important role which many of these component elements would later play in education.

The first philosophy was essentially aristocratic in its orientation. It was largely an adaptation to the American environment of the new German ideas on university education which American scholars, studying in Germany in ever-increasing numbers during the early decades of the nineteenth century, were bringing back and introducing into the American college. Higher educational institutions were not to be directly or immediately involved in the problems, the needs, the concerns of the society about them. Rather the ends of society were to be served through a scholarship which was isolated from the currents and pressures of the workaday world. Thus its values centered around such ideals as academic excellence, freedom and immunity for the scholar in his pursuit of truth, unfettered time and solitude for scholarly reflection. Although it did not turn away from the traditional educational programs—the classical studies, moral philosophy, literature—its priorities were upon pure science, basic research, the laboratory, the experimental method, graduate education, the training of the superior student.

The second educational strain—the philosophy of involvement—was permeated with the spirit of egalitarianism. It was a philosophy indigenous to the American environment. Its purpose was directly and immediately to serve the needs and interests of its society. Its commitment was to mass education. Its priorities were undergraduate teaching and making the benefits of the new education widely available to all of the people of the state.

The philosophy of involvement was the product of a materialistic and utilitarian society which had before it the promise of a new high level of material abundance; but which also had much

work to do—a continent to be developed, railroads and factories to be built and manned, farms to be laid out and improved. Children of the Enlightenment that they were, the educational mentors of the philosophy of involvement believed deeply in education, but they believed in it primarily for what it could accomplish, its use value. For them, the relevant education was the useful education. Thus, its orientation was toward the vocational, toward the practical education and technical training which would equip students for carrying out the work which had to be done in this new society. It also was a philosophy deeply committed to the new science as a relevant education. However, it believed in the new science because of its potentialities for being adapted and applied to the common purposes of life. Its drive was to use science technologically.

The Land-Grant Act established no one concept of the relevant education. The new institutions were given no single and secure purpose. Rather, their mandate was a composite of ideas, full of confusions and anomalies and cross-currents of competing purposes. In short, the land-grant institutions were offered two differing paths to the relevant education, and in the years which lay ahead, each of these differing philosophies of the relevant education was to have its own protagonists, its own colorful leaders to carry its banners, its own supporters and camp followers, ready to march off in differing directions in search of the relevant education.

The meaning of the land-grant concept as an educational philosophy had to await upon a process of interpretation, a process which only the new institutions themselves could set in motion. The new colleges, equipped with only confusing and conflicting guidelines, were left with the responsibility of working out their own concept of land-grant education. Theirs was to be the task of interpreting and implementing their mandate, of determining how they were to meet their responsibilities for developing the relevant education. In short, the land-grant idea was to become an open-ended concept, the product of a continuously moving process, a process which was forever fluid and flexible.

My thesis is this: The fact that the new land-grant institutions were not created upon a single, unified concept, that they have never been sure and confident in their purposes, has been a posi-

tive good. For it has forced them into the development of a process for achieving the relevant education out of a complex of competing, conflicting, and even antagonistic educational ideas and philosophies. It is this process which is creating a modern land-grant university which will continue to be a useful and viable educational institution in a society which is changing with revolutionary speed.

Let us consider for just a moment the kind of one-sided, narrowly based educational program the land-grant institutions might have developed if they had been built solely upon either of the two competing educational philosophies which prevailed in the latter years of the nineteenth century. American society and its educational leaders were not yet equipped with either the educational knowledge or the sophistication to develop any single, unified, and comprehensive philosophy of education which would have fit the changing needs and circumstances of the American people. They had no concept, for example, of the need for a broad-based education within which specialized knowledge might be fitted. They did not understand the need for an educational philosophy's being a moving concept. They probably could have obtained no consensus for the suggestion that the most relevant education was to be achieved through a common sharing of the best values of the two prevailing educational strains.

If either of the two prevailing philosophies of education had been accepted as the single, unified land-grant concept of education, the land-grant educational program would have been narrow gauged and one sided. For both of these philosophies were narrow in their orientation. They would have taken different, but equally narrow, paths in their search for the relevant education. Each had yet to learn and appreciate the true worth of the values which the other held. Neither yet understood the need for developing an educational system based upon these values held in common.

In the years ahead, both were to view specialized education as the relevant education. Specialized knowledge and specialized training were to be the common building blocks of both educational philosophies. Each was only awaiting the day when sufficient specialized knowledge had been accumulated to make its own particular brand of specialization possible. We can only speculate

upon the kind of land-grant educational program which would have been developed if either of these philosophies had had the building blocks of specialized knowledge in its hands and had been unfettered and unencumbered by the competing ideas of its rival philosophy. Perhaps the exigencies and the imperatives of American society would have forced such a single concept land-grant institution into broadening out and diversifying its purposes to meet the multiplying needs and desires of the American people.

We do know, however, about the kind of educational programs which the land-grant universities, over the past hundred years, have been developing out of a process of accommodation between the differing value systems built into the original concept. It is my belief that this process has achieved a progression of educational concepts which has made land-grant education continuously relevant to its time.

The process which the land-grant universities set in motion was essentially pragmatic and neutral. The participants in the process were far from neutral, but the process itself was without a philosophical orientation. It was not weighted toward any particular educational value system. Nor did it have a broader understanding or clearer insight into what composed the relevant education. Its component parts were made out of the prevailing educational philosophies of its day. In short, it has been a process free to come up with varying educational answers, suited to a particular time and circumstance.

Three factors made this process operative: First, the land-grant universities' covenant with democracy to be the "people's colleges"; second, their consequent commitment to developing educational programs relevant to the needs and interests of American democracy and its people; and third, their broad educational mandate which gave them a wide range of choice in selecting that relevant education.

In sorting, evaluating, weighing, and selecting educational programs out of all of the possibilities laid open by the institutions' broad educational mandate, this process was, in part, an operation of compromise and accommodation. It was a market place for competing ideas. Nevertheless, although countervailing influences were certainly an important force in making this process

work, it was not a process arranged and ordered merely by a kind of mechanical balancing out of countervailing forces. Rather, it was guided by another kind of inner logic. The inner logic of this process, the logic which made it so effective, was the pragmatic need which the land-grant institutions continuously faced in meeting the educational imperatives of American democracy.

Accommodation and compromise were not enough. Land-grant institutions had also to meet the efficiency tests of a pragmatic society. They had to select and develop the kind of programs which that society needed and wanted. The land-grant institutions have had to be tough minded and hard nosed. They have had to confront the realities of the American environment as they were. They have had to develop solid and substantial educational solutions.

The force of the land-grant process has consistently been to bring the land-grant concept into the center of the educational spectrum. It has always foregone the extremes in educational philosophy. The drive of the process has been toward synthesis and integration. I maintain this proposition despite seemingly good evidence to the contrary. For the land-grant concept could, with reasonable justification, be pictured as having, during certain long periods in the land-grant institutions' history, forced their educational programs into a single, narrow groove. Conversely, during recent years, the process could be depicted as having acted as a shattering and splintering force which has been throwing their educational programs out, in bits and pieces, in all directions.

The single, narrow, extreme answer has really never been acceptable to the land-grant process. We all know that during the last years of the nineteenth century and the opening years of the twentieth—in those halcyon days before World War II—that the land-grant colleges were choosing to interpret their purposes and their goals most narrowly and restrictively. Seemingly, the philosophy of applied science and specialized vocationalism so completely outweighed all other educational values that there was real danger that the land-grant colleges would be unable to break out of the narrow vocational restrictions being placed upon them.

The case can be made that in those years when applied science and vocationalism were at full tide in land-grant education,

the colleges were offering the relevant education for a society which was requiring ever-increasing talent, trained in the practical arts. Perhaps this education fit quite well society's prevailing notion of the relevant education.

The fact is, however, that the countervailing forces at work in the land-grant process never permitted the land-grant concept to be interpreted as narrowly or restrictively as it might have been if the colleges had been given only one fixed purpose. The values of the other educational philosophies were always present, acting as a real, if sometimes very weak, balancing force. Their protagonists were there to criticize, to protest, to suggest alternative courses of education. For example, despite the strong tide of vocationalism which seemingly had engulfed land-grant thinking in those years, the land-grant institutions never accepted those extreme views of vocationalism which saw the relevant education as a kind of manual training process in field and workshop and saw the colleges as little more than trade schools and model farms.

During this period, moreover, the values of the other philosophical strains were making strong thrusts forward. Graduate education was becoming an important land-grant purpose. Basic research and laboratory-based science were being established as prime functions. Standards of excellence were being set. Concepts of academic freedom and freedom from harassment from local pressure groups and legislatures were slowly beginning to evolve.

Even as specialized, narrow vocationalism reached flood tide, changing forces in American life were already bringing new tests for relevancy to land-grant education. Growing specialization in the American economic process and the consequent diversification of vocational groups in American society were calling for increasing diversification in vocational and professional training, new professional schools, new courses of study, new majors, new disciplines. In a world of war, farm depression, and industrial and financial boom and bust, curricula in the growing and strengthening social sciences were increasingly relevant.

Most of us have been able to observe at first hand how the land-grant process, as it has gathered speed and momentum in recent years, has seemingly become a kind of centrifugal force, pushing the activities of the land-grant universities out in all directions. We

have seen ever-increasing specialization at work: the division and subdivision of knowledge into ever-more specialized disciplines; the proliferation of courses and of major fields of study; the growth of specialty professional schools; the development of increasingly minute new research areas; an ever-expanding number and variety of service projects; even the creation of such special purpose peripheral facilities as knowledge centers, research parks, service institutes. In short, we have witnessed the development of the multiversity.

Does the existence of the multiversity represent a failure of the Land-Grant process to develop the relevant education? Is this process failing to fulfill the great potential which it seemingly had for achieving an educational synthesis? Is the multiversity merely an easy accommodation to irreconcilable demands and clamors? Is it simply a kind of academic supermarket which merely offers a wider selection among narrow brands of specialization? Does it merely have a greater variety of specialization upon its shelves?

All of us who have watched the development of the land-grant multiversity recognize its weaknesses, the disadvantages it has in attempting to create the relevant education. Nevertheless, the multiversity, I believe, stands today as the single best equipped institution for offering the relevant educational programs needed by our scientific and technological society. If we did not have the land-grant multiversities carrying on all of the functions which they perform in our democratic society, other public educational institutions would have to be invented.

Let us consider for a moment what the land-grant process has already achieved in the land-grant multiversity. The land-grant multiversity represents the achievement of a stable, yet flexible, institutional balance among the three great functional areas of teaching, research, and service. It is this unique functional balance which not only has given the modern land-grant university its identity but has also made it the enormously useful social institution that it is today. This functional proportion and balance is giving the university a coherence and integrity which is increasing its capacity to resist the distorting pressures for casual, opportunistic development.

Not only has the university achieved a workable balance between its three large functional areas, but in its present programs and working processes it has gathered and balanced the best educational values and concepts from all of the educational strains which have been its inheritance. While striving for standards of high academic excellence and for quality education, it has broadened and deepened its commitment to mass education. New balances are beginning to be attained between graduate education and undergraduate teaching. Basic and applied research have achieved productively balanced relationships. Never before has the university been so immersed in the society of its day, so concerned in the solutions of its problems, so widely committed to service to the larger community. At the same time, even in the face of growing attacks on the academy itself, the concept of academic freedom and immunity for the individual scholar in his pursuit of truth has been strengthened and maintained.

Today, the land-grant university is one of the most swiftly changing institutions in a rapidly moving society, and it is gathering speed for probably even greater transformation. We are, I believe, at another of the crisis points in the development of the land-grant concept when the forces of our society are again requiring a new interpretation of the relevant education. The education of the multiversity, as we know it today, is not, I believe we can all agree, adequately meeting the educational needs of our scientific and technological society. Its education will be even less relevant in the world of the future.

It is inevitable that there should be wide disagreement among philosophers of education upon the question of what composes the relevant education for a world so complex and so confusing as ours. Unfortunately for the scholars who seek agreement on what the relevant education is, they cannot open the horse's mouth and count the teeth. There is no objective count that we can take of the parts which go together to build the kind of knowledge which makes for a relevant education.

It is my belief, however, that the relevant education for these latter years of the twentieth century lies in a process which works toward the development of the individual as a total yet many-sided person, who has not only professional but also varied intellectual,

cultural, artistic, and moral needs which require fulfillment. I believe that somehow this kind of a relevant education is going to have to be achieved through educational programs in which specialized knowledge and training are attained within the context of a broad socio-humanistic understanding.

Today, more than ever before, the relevant education is not to be achieved through either an easy, one-sided answer or an easy accommodation and acceptance of conflicting answers. The liberal arts education—even if it were oriented around the great issues, the great problems, the great values of our times, as is frequently proposed—cannot be sufficient in our scientific and technological society. For probably only the nuclear bomb can turn the clock back to a simpler day when such limited education would be enough. Nor is the narrow professional education—although the training of such professional talent is certainly a necessary educational function in our technological world—adequate to meet the needs of an interdependent society which is facing great social and political crises. The land-grant process with its pragmatic need for meeting the imperatives of its society, cannot accept such easy but incomplete panaceas. The land-grant process cannot accept as the relevant education the kind of negative balancing out of the disciplines which merely results in a more varied mix of specialized answers. This, as we know, has largely been the educational program of the multiversity.

The task before the land-grant university today is that of bringing its rich variety of educational offerings into new syntheses in which a student's specialized training can be integrated into a broader, intellectual, cultural, and aesthetic experience. This will be no easy task. It will require great creativity and broad understanding of the needs and nature of education.

The land-grant universities in 1968 stand much in the position in which the young land-grant institutions stood a century ago. They have before them the job of fashioning an education relevant to their time. They have a rich variety of ideas with which to work in creating this education. Yet, again like their predecessors of a hundred years ago, they still can only see dim foreshadowings on the wall of what the relevant education of the future is to be. They have the land-grant concept as an open-ended process. It is a

working process which can be pluralistic, flexible, and experimental, one that allows for compromise and accommodation. Yet, it is a tough, pragmatic process whose only drive is toward educational answers adequate for their times. Out of this process, the land-grant institutions will, I believe, continue to develop a concept of land-grant education which will fit the needs of the democratic society they were created to serve.