SCIENCE AND CULTURE

A report of the "Science and Culture" series of evening meetings conducted by the faculties of the Social Studies and Science Majors.

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A series of lectures and informal discussions conducted by the Social Studies and Science faculties and participated in by members of the College community as a part of the program of evening meetings.

THE CONFLICT WITHIN CULTURE

Lewis W. Jones

This is the first of a series of six meetings devoted to the general subject of "Science and Culture".

These meetings are being conducted jointly by the science and social studies faculties. There will be two formal lectures by members of these faculties at each of the six meetings, after which there will be a 30-minute panel discussion participated in by the distinguished group of people you see before you on the platform. We also invite the participation of the audience in the panel discussions with questions and comments from the floor. Each lecture will be rigidly limited to not more than twenty minutes and this time limit will be fairly but ruthlessly enforced. Any precious pearls of wisdom which might be lost by this time limitation may later be brought out in the panel discussion. Except for the first and last meetings, the formal lecture part of each meeting will consume the usual 45 minutes, after which there will be the usual 5-minute intermission before the discussion begins. At the first and the last meetings a somewhat longer time will be used in the formal presentations in order to give the chairman an opportunity to make a few extremely relevant and weighty remarks.

My own particular function at these meetings, apart from keeping order throughout and seeing that the discussion conforms at least to the local standards of civilized behavior, is to get the meetings off to a good start and to end them on a high note.

We have deliberately chosen as the subject for these meetings the somewhat inaccurate title "Science and Culture". Obviously science is a part of our contemporary culture. We have chosen this particular title in order to emphasize what we believe to be the basic conflict in our modern civilization, namely, the conflict between the new world of science and technology, on the one hand, and the older institutions and ways of behaving on the other. What we are confronted with, therefore, is a conflict within culture.

By culture we mean the social heritage of man as distinct from his biological heritage. Tylor defines culture as "that complex whole which includes knowledge, belief, art, morals, law, custom and any other capabilities and habits acquired by man as a member of society". Since in this definition the use of material objects is not mentioned, I wish to call particular attention to the fact that these material objects, such as tools and machines, or, as the economist would describe them, the "means of production" and "durable consumers' goods (houses, radios, pictures, and bath tubs), are a very important part of culture. In other words, the physical plant of the General Motors

Corporation is as much a part of culture as the behavior pattern of sitting down. Culture, therefore, consists of the sum total of material things and of non-material ways of behaving acquired as the result of our membership in a social group.

I have consciously emphasized the material aspect of culture in this definition, even at the risk of disagreement with some of my colleagues, because it is the great changes in our material culture, particularly in the last two hundred years, which have precipitated many of the changes in our adaptive culture, and have thus given rise to the maladjustments and cultural lags which I have called the conflict within culture.

It does not take a particularly acute observer, nor does one need be an alarmist, to realize that the adaptive institutions of our modern culture are undergoing profound and even violent change. Although the conflict is a many-sided one, and it is often difficult to decide who is fighting for what, I think the clash is essentially one between the dynamic force of modern technology and the resistant institutions and ideologies handed down from a more distant past. It is a conflict between an individualistic conception of private property and an industrial technology which by its very nature is cooperative. It is a conflict between an industrial system of enormous potential productive capacity and a market of limited buying capacity. It is a conflict, as Veblen pointed out some fifteen years ago, between an industrial technology manned by engineers and sustained by research scientists and a chaotic, anarchical and capricious price system manipulated by business men, lawyers and financiers. Finally, I trust I do not need to tell you, it is a conflict between human needs and a whole system of traditionally entrenched and legally sanctioned vested interest.

If my diagnosis is correct, this conflict within our culture has brought us to one of the great, decisive periods of change in human history comparable in scope to the transition from the cultural synthesis of the Roman Empire to that of Mediaevalism. We are living in an age of transition from one cultural synthesis to another. In contrast to the rosy optimism of the 19th century with its belief in orderly progress, liberal humanitarianism, and the beneficent working of laissez-faire capitalism to produce through free trade and free competition universal peace and prosperity, our contemporary world is haunted by a sense of impending doom. With the last world war fresh in our memories, and a minor world war being fought out in Spain, the great powers are frantically preparing for another war on an even more magnificent scale. After two centuries of rapid industrial development and a tremendous increase in our productive capacity, millions of people in Western civilization are living in a condition of dire poverty. Fascism, National Socialism, Communism, The New Deal, and that dreadful assassination of character which is now going on among the literary communists, who have discovered for the first time the materialistic interpretation of history, and have endowed it with mystic significance, are all aspects of this cultural conflict. War, revolution, and class-struggle are violent forms of social legislation which are resorted to when lags in one aspect of culture dam up the dynamic forces of change.

Social change is constantly taking place peaceably, but it also often takes place violently. The intensity of the frustration and conflict within our culture would lead us to anticipate, as Hogben has said, that "for years to come the life of Western Civilization may be less gentle. There may be less reasonableness, less understanding, more violence."

The specific characteristic of our present culture which distinguishes it from all other cultures of which we have knowledge is the extent of its dependence at least for its material support on the natural and physical sciences. So far I have dealt only with the impact of technology on traditional ways of behaving. In the few minutes remaining to me, therefore, I want to examine the relationship between science and technology, and the impact of scientific ways of thinking on our contemporary culture.

It is customary to distinguish between "pure" science and applied science, or technology, and to assume that the development of technology is "caused by" the growth of pure scientific discovery. While I hesitate to cast reflections on the virginity of "pure" science, I think that most contemporary scientists would agree that advances in both science and technology have resulted from a fruitful union between the two. One is not the "cause" of the other, but both are interacting social phenomena, and both are culturally determined. Certainly many of the advances in so-called "pure" science have resulted from the laboratory use of technological devices, and many of the problems of "pure" science have been suggested by experience in the industrial arts. Both science and technology depend moreover on the institutionalization of certain patterns of behavior and thought generally referred to as the empirical method: that is, the method of controlled observation and experiment.

If I have already undermined your faith in the purity of science, I hope also to disabuse you of the idea that scientific discovery springs spontaneously from the minds of a few great men. Please understand me; I am not saying that individual scientists are not truly great, or that they are not entitled to the greatest honor and reward. The pity is that their contributions are so often undervalued in terms of their true social worth. What I am saying is that there is probably no dearth of potential ability for scientific discovery, and that the progress of science depends, not so much on the individually great mind, as on the institutionalization of the practices and procedures we call the scientific method. Indeed, I would go further, and say that science only flourishes when it accepts this social relationship, and is recognized as the property of the masses of men, and not of a small group of "clever" people. Whenever it falls into the hands of a leisured class, remote from the toil of ordinary people, and is used as a badge of social superiority, or becomes a solace for neurotic intellectuals who want to escape into the logical symmetry of complete abstraction, it ceases to be science, because it denies the very laws of its own growth. It degenerates into one of the irrelevancies of life, taking its place with auction bridge and cross-word puzzles. It is pure, if you like, but sterility is the natural consequence of this kind of purity.

The most common definition of science, in the language of the school texts, is that science is "organized knowledge", and knowledge is ordinarily taken to mean "facts". I have interviewed students who said they wanted to major in science because science is definite, and in it you learn facts. They believed that studying science consisted of memorizing a body of facts, and going through a series of laboratory exercises the outcome of which they knew in advance. Having thus achieved the absolute in knowledge, they would be forever absolved from the painful necessity of thought. In defense of our science standards, I hasten to add that such students were invariably freshmen, and that they underwent a crisis of moral and intellectual disillusionment as their secure world of absolute scientific knowledge was slowly dissolved by more advanced study.

Along with this notion of science as organized facts, goes the belief in a dichotomy between facts and ideas. Students frequently come to me to learn The Facts--not about Life--but The Facts about the economic order. I am told that they are "simply filled with ideas and principles" and have now reached a stage where they want some good, hard facts, usually to back up their ideas and principles. I have never understood quite what one is supposed to do with facts in the total absence of any idea about them; nor what is meant by an idea which is unrelated to any fact. According to this point of view, it seems that all ideas are not only born free and equal, but they are immaculately conceived as well. Facts, on the other hand, are necessary but deplorable attributes of our mundane relationship to the lower animals, which should be kept as remote as possible from our finer and more precious existence.

The definition of science as "organized knowledge" is useless, first, because much organized knowledge is not scientific; and second, because scientific knowledge is not static, but is constantly being modified and revised as new facts are discovered. Knowledge of phrenology, tabletipping, or advertising is not science, though any of these things might be scientifically studied. Knowledge of the practical arts of cooking and dress-making, or of law, politics, navigation is not science, nor is knowledge of the pure arts of painting and sculpture, though any of these may make use of scientific knowledge. I shall go further and say that medicine is not science; it is an art that is based on scientific knowledge. Strictly speaking, chemistry, physics, and biology are not science; they are fields of scientific investigation. Science can only be defined in terms of a method and a faith.

The scientific method is the method of investigation by the process of hypothesis, experiment, observation, and measurement. Investigation by quantitative analysis is the essence of science. It is the method of discovering relationships among phenomena by inventing appropriate concepts and symbols in terms of which these relationships can be measured.

Secondly, science is a faith. To quote Thurstone:

"It is the faith of all science that an unlimited number of phenomena can be comprehended in terms of a limited number of concepts or ideal constructs. Without this faith no science could ever have any motivation. To deny this faith is to affirm the primary chaos of nature and the consequent futility of scientific effort. The constructs in terms of which natural phenomena are comprehended are man-made inventions. To discover a scientific law is merely to discover that a man-made scheme serves to unify and therefore to simplify, comprehension of a certain class of phenomena. A scientific law is not to be thought of as having an independent existence which some scientist is fortunate to stumble upon. A scientific law is not a part of nature. It is only a way of comprehending nature."

I hope I have not conveyed the impression that science is something quite remote from our ordinary ways of thinking or that it is somehow in conflict with our fresher and more spontaneous feelings. Even the most mystical among us makes daily use of scientific ways of thinking. This is, of course, inevitable as a result of our cultural conditioning. I challenge you to think about almost any of the commonplace things of your life at Bennington College without engaging in quantitative ways of thinking. You are constantly asking the questions of "how much?", "how far?", "how many?" and "to what extent?"; and you are not satisfied until you get an answer in quantitative symbols.

If you are concerned about your weight, you make use of that old precision instrument, the scales. If you are concerned about your height or your girth, you immediately make use of certain arbitrary units on a tape measure. If you are feeling ill you attempt to establish a correlation between your malaise and the number of degrees your body heat will push a certain amount of mercury in a glass tube.

If you are concerned about your popularity, you measure it in that quantitative collegiate unit of social success, the number of cut-ins at the next dance. You regulate your day by a machine which ticks off units of measurement between the recurrence of certain astronomical phenomena; and at Bennington College in making out your study program, you make use of that rather strange and hardly precise local unit of measurement--one-fourth, one-eighth, one-sixteenth, or one-thirty-second of your working time. Your instructors, however, are not privileged to make use of similar quantitative measurements in reporting on your work, but are compelled to resort to the older and therefore more respectable verbal symbols.

I am not suggesting that these commonplace ways of thinking are examples of the use of the scientific method. They are, however, rational and quantitative ways of thinking, and so belong to the same logical family. Rational thought is of course not new, nor modern. It has an ancient and honorable tradition going back to the dawn of human consciousness. Logic, or the art of drawing correct conclusions from stated premises, is a part of the rational method. So also is dialectic, or the art of logical disputation. Scientific method includes the use of these old-established methods of rational thought. It uses logic as a means of formulating problems and dialectics to suggest hypotheses.

But the distinguishing characteristic of the scientific method is that it does not rely on the processes of thought alone, however logical they may be, to arrive at its conclusions. The scientist tries to devise increasingly reliable techniques of measurement, so that his conclusions may become increasingly impersonal and objective. He attempts to find ways of measuring even the errors in his own thinking. Neither the generalizations arrived at by deductive logic, nor the generalizations arrived at by his own patient researches, are regarded by the scientific man as ultimate truth; they are merely hypotheses which are valuable in so far as they become a fruitful starting point of further investigation.

The scientist does not deal with the real, concrete world any more than does the artist. What he does is to invent symbols and concepts by the use of which he can find order and relationship and so arrive at reliable "recipes for action". In his search for tools which depend as little as possible on the personal bias of the observer, he tends to rely more and more on quantitative or mathematical analysis. Mathematics, as Hogben has said, is merely "the grammar of size", as opposed to the more familiar verbal language, or the "grammar of kind"; and the scientist is discovering that many apparent differences of kind can equally well be expressed as difference in size.

It is clear that science is neither something apart, nor something new, nor is it the product of the modern world. It is no accident that we date the beginnings of the modern world of science and technology from the Renaissance of classical and Arabic learning. The conflict within our culture is not, or rather should not be, a conflict over the use of the scientific method. The defendants of the classical culture in our contemporary world might logically be the defenders of scientific humanism. As such, they should be using the scientific method to isolate the "essences" of things, and to break them down into more precise units of measurement, rather than to rely on the exclusive use of verbal dialectic to defend closed systems of thought. It is apparent, however, that there is an intellectual conflict within our culture; it is essentially a conflict of authority, between the authority of a body of dogma and the authority of the scientific method.

Those of us who are participating in this series of meetings accept the authority of the scientific method. We believe, that, at this particular crisis in our cultural development, when people are taking refuge in bomb-proof intellectual positions or rushing into mystical Youth Movements it is appropriate for us to affirm our faith in the continuance of rationality. In this affirmation of faith, and in our recognition of the common problems which confront us as scientists and social scientists, we are a United Front. But, like all United Front movements, we probably have dissendent groups in our midst. You will probably find that these differences of opinion will be expressed in the papers which will be read, and indeed no attempt has been made to reach agreement in advance. We hope that the audience will participate vigorously in our attempts to iron out our disagreements.

I shall now turn the meeting over to Mrs. McCamy, and after her, to Mr. Newcomb.

THE NATURE OF CULTURE

Julia B. McCamy

Mr. Jones has been defining some of the terms that will recur in these discussions. One of these, culture, is familiarly used to describe in a vague way one restricted aspect of our social life. A person with some understanding of one or several artistic fields is often said to be "cultured". He is more cultured if his taste leads him to prefer all those things that are best in art and literature. During this series, at least, we must forget these conceptions of the term.

In the vocabulary of the scientist and social scientist culture means all the things, both material and social, in our extra-physical inheritance, all of those things which are not part of our biologically inherited equipment. Sometimes as an aid to precise discussion our values, institutions and philosophies are called the social culture, while our mechanical equipment and technical processes--our technology--are called the material culture. The social and material culture, which includes the whole complex of techniques of maintaining life and ways of understanding life, all of our institutions, attitudes, habits, and machines make up our social inheritance or culture.

By this definition some animals may be said to have rudimentary culture. By observation and imitation, animals can occasionally profit by the experience of others. Animals can communicate with each other and can learn from each other but animals are handicapped in the process of teaching and learning by the lack of language. Even among the great apes, our closest kin among the animals there is nothing that can properly be called language. Using a vocal apparatus very similar to the human type, an ape can make sounds that will express his emotional state. He can express fear and excitement in such a way that other apes will become afraid and excited, but he cannot indicate the specific nature of his real or imagined troubles. His screeched warning cannot tell companions to beware of leopards instead of lions, approaching from the south as distinct from any other direction. A set of conventional usages with which he could describe a new circumstance in abstract terms would be language; and language as a means of communication is unique to mankind. This ability makes it possible for man to transmit more learned behavior than animals can and, most important, he can speak in abstractions. Lacking language the social inheritance of animals is restricted to the perpetuation of a few advantageous habits which make up the total of animal culture. It is the advantage of language that made it possible for man to develop and maintain an elaborate culture which distinguishes him from his animal brothren.

From our point of view it is difficult to imagine a cultureless human being. If we could observe one with his fund of physiological reactions and biologically inherited behavior patterns only, he would hardly be recognizable as a member of our exalted species. It is easy to understand why all congenital deaf mutes were, at one time, thought to be feebleminded. From birth the mute is cut off from the verbal instruction which helps the normal child gradually to absorb his culture. By imitation the mute can learn a few manual skills. Unless he is taught a language substitute, there is no way for a mute to share the complexities of our social heritage.

There are no very authentic records of abandoned children who have survived in the forest, cut off from human contact. Suppose we try to imagine what would happen if two or three hundred human infants of the best stock were placed on a deserted island and furnished (in some way) with food and the necessary protection. What would they be like in maturity? How far could this species of primate with a large brain advance in one generation? It is barely possible that some very meagre means of communications might develop, but it is improbable that even one poorly chipped stone implement would be produced. It is most unlikely that even the brightest member of the group would discover how to make fire. Culture as their parents had known it would vanish, the long slow process of invention and transmission would have to begin again.

There are many ways to play this interesting game. Suppose you placed on this or another island a group of men, each of whom had been trained as a lawyer. These men could, possibly, do a good job of organizing the community. They would know from previous observation that it is possible to domesticate plants and animals, but they could not produce very striking results in their lifetime. With their meagre knowledge of astronomy and mathematics, they could do very little toward reconstructing the calendar. Even if there were iron on the island, I doubt if there would be enough technical knowledge in the group to make possible its use.

I do not mean to reflect on the capabilities of lawyers. The lawyers had been specialists in one phase, the legal phase, of their culture but had understood the fundamental processes and backgrounds of little else. It is impossible for one man to master all the phases of his culture. Culture has its wealth of content because it is carried by groups of individuals, social groups. One of the ways to understand the meaning of the word, culture, is to realize that a lone individual cannot be social, cannot have culture. Our culture consists of the relationships of individuals to individuals, of individuals to groups, of groups to groups, as well as the relationship of individuals and groups to the natural world and to material objects.

As soon as a child draws his first breath as an independent being, he becomes the center of a set of complex relationships. He has first his family status: son, brother, grandchild, nephew, cousin, etc. He is a citizen of his town, his county, state, nation. He is one unit in a complex social structure, a structure composed of these intangible relationships. As he grows older he establishes new points of contact with more individuals and social groups. He becomes a member of an age group in his school class, he goes to several schools, he joins clubs, he keeps his money in a bank, he has business relationships, and many more. He is intimately integrated, directly and indirectly, with the whole human family and its natural surroundings. The death of this man cannot destroy the social structure of which he has been a part, for society is continuous.

Society may change slowly or so rapidly that the resultant is hardly recognizable as a legitimate descendant. Even an Indian tribe suddenly confronted with the overpowering western culture, forced to abandon its old ceremonies and old ways of life, cannot be said to lack culture. It may lose its Indian culture, but change and substitution do not mean that it was ever for a moment without social organization and culture of some kind. The tribe and its individuals have merely merged rapidly and abruptly with another social group.

At the college here we can see in a small way the process of continuance and change in a social group. Each graduating class takes many individuals from the group, but this is not a death blow to the college. The ranks are filled from below and the social structure of the group remains relatively unchanged. There will be reoriented friendship groups, new outside influences from different family groups, new counsellor-counsellee relationships and many other minor changes. These might gradually and indirectly effect some change in the college structure, but it is very unlikely that an alumna returning three years later would find much difference in the college organization except new faces. Change would be slow; it would be the result of the interaction between new individuals from different backgrounds and college tradition.

The changes in material culture, or technology, are easier to observe and measure than social changes are. Our industries and their products are, however, a completely integrated part of the total social structure. The symbolic and ritualistic ties, binding technology to men and groups of men interlace it in our lives as strongly as the obvious utilitarian purposes it serves. The technology of a culture can be under stood only by understanding its relation to the whole culture. The products of technology, however, may survive, not only in tradition and influence but in actual physical fact. Without accompanying documentary records, the survival of the sword of Napoleon would tell us little about him or about France. We might guess that he carried it for its prestige value or for self defense. We would know that the technique of tempering steel was well advanced at that time and that gold was used for decoration. We could not know the sword's symbolic value without knowing the culture that produced it.

It is impossible to trace accurately the history of our social culture for more than a few thousand years into the past. Documents make this type of research possible and documents end, so to speak, with the beginning of writing, about 3000 B. C. But human culture did not begin with writing. By the time our ancestors learned to write, our culture was already amazingly complex. We can never know precisely the nature of the social structure which preceded written records, but if it was comparable to the material culture we can suppose that it too was variegated and intricate.

When we start tracing back to find the origins, the roots of our social structure, we quickly come to the place where writing can help us no longer. All that remains are the products of technology and, by inference, the way they were produced, and again by inference the role they played in society. With material objects alone as our guide, we have a slight clue to the history of our culture before writing. Alphabetic and hieroglyphic writing was one of man's later accomplishments. Before, he had discovered every important mechanical principle that we use today. He knew the use of the screw, wheel, lever, and the inclined plane. Since that early time, no important plant or animal has been domesticated. From the beginnings of simple chipped stone tools about 100,000 years ago, man's technology slowly became more complex. There were many interruptions and set-backs, large in the terms of a life-time, but small in the life of the species. This technical complexity not only increased, but it accelerated. Not only were there new inventions; they occurred oftener. The pace increased until we attained the dizzy speed of today. Nevertheless, in the remote past, we can find the beginnings of our modern technology and in the past preserved for us in writing, we can trace out most of the elements of our social inheritance.

In this series, our interests as twentieth century Americans, will lead us to examine some of the aspects of the culture of the western world. I have been speaking principally in terms of that culture. Perhaps you have noticed that I have not said our culture "progressed", but that it became more complex. In describing culture, or a specific culture, it is not necessary to evaluate it. Western culture has become the most complex culture the world has yet known. I cannot say that it is the best culture for man; there is no way for me to evaluate that. There are other cultures as ancient and as human as our own. We won't be discussing them, but I would like to emphasize that human culture and western civilization are not synonymous. Western civilization is our particular heritage, it is our culture, but it is only one segment of the social inheritance of the human species.

CULTURE AND THE INDIVIDUAL

Theodore Newcomb

We now turn to another phase of the problem of culture. We have seen what the social scientist means by the term: it refers to ways of acting and thinking which are not inevitable for human beings just because they are human beings, but which are almost inevitable for members of a given group because of tradition. We have also seen that, as the word "tradition" implies, there is something very tenacious about culture; it tends to stick; it appears to have a momentum of its own.

I am going to approach my particular problem by means of a crudely put question: where must we think of culture as residing? In groups or in individuals? In both, you will reply, and you will be right, but nevertheless there are two very different ways of looking at the matter. From one point of view the term "culture" is merely an abstraction of the sum-total of the contributions of all the individuals who share it. Culture, thus viewed, is only a concept, like the concept "mammal"; actually there is no such entity as "mammal"; it is only a convenience for purposes of looking at something in an inclusive manner.

An eminent social psychologist of this faith has said what he regards to be the final and conclusive word on this point: "A group does not have a nervous system." The remark is perfectly true and perfectly irrelevant. Of course culture resides in individual nervous systems, and this is true even of material culture. For typewriters and locomotives and radios, and even such simple forms of material culture as knives and clay pots, represent culture only so long as habits which make their use possible reside in individual nervous systems.

From the moment that such habits of adjustment cease to exist in individual nervous systems there is no culture, and even objects formerly representing material culture are now but meaningless lumps in the environment. I cannot tarry longer on this point, which may seem very dubious to some of you, but I'll gladly meet you with swords at forty paces on some later occasion.

Yes, culture resides, in this technical sense, in individuals. But it can scarcely be said to live, in that sense. For those social metabolisms which are necessary for the on-going life of culture, even though we think of it as residing in individuals, are to be found only among groups. All this I hope to make clear by sketching what I may call the life-history of culture as it resides in an individual. Just how is culture acquired by the individual?

I might short-circuit the answer to this question by pointing out that it is the end-result of trial-and-error learning, in the midst of an already existing culture. But such a truism would only obscure the dynamics of the process. We need to know, first, what equipment the infant has for launching upon the process of acquisition, and second, what is the nature of the process.

The evidence is very clear regarding the first of these problems. The infant begins the process with but one tool, or one kind of tool. But by means of that one he acquires others, and with the whole kit of them he soon becomes very adept at selecting aspects of culture for himself. That tool is appetite, or need, or desire. The culture within which he finds himself is one which, very fortunately, is full of frustrations. Sooner or later he finds that his wants do not automatically get satisfied. If they did, he would develop into what I might call a homeoform amoeba, with the personality of a sponge. For it is in the process of meeting frustrations, of sidestepping them, of tacking, of finding detours around them--always in pursuit of the satisfaction of wants--that some of the most important personality characteristics develop. Personality is thus, in large measure, an outgrowth of culture, which serves to thwart the immediate satisfaction of human needs.

What I have just said about culture may seem to be casting it in the role of the villain of the piece, as if it were some heaven-sent scourge. This, of course, is only part of the truth. Culture serves to fulfill human needs, as well as to thwart them. Culture never serves merely to thwart needs; it merely serves, at some points, to dictate the manner in which they shall be satisfied. No culture includes a taboo on eating, but all known cultures impose certain conditions of eating. Culture must indeed be thought of as beneficent even when rather exacting conditions are imposed. The exacting conditions may long since have outlived their usefulness, except in the sense that some kind of conformity, however atavistic, is better than none. But it should also be noted that by no means all aspects of culture are buttressed by sanctions. Speech provides a good example of this: a child is not compelled to talk (indeed, he cannot be), but language is useful in the service of needs, and if he wants to talk there is commonly but one vernacular available.

It is nevertheless true that very early in life distinctions between "right" and "wrong" ways of behaving are made. These derive their importance from the fact that they are intimately associated with the primary needs of life. I cannot describe the process at length in the few minutes at my disposal, but I can sketch it briefly. The infant's needs must actually be described, to begin with, in negative terms. He wants, not milk but relief from hunger pangs, which is incidentally provided by milk. He wants, not warmth nor a closed safety pin, but the absence of cold-discomfort and of pricking-pain.

But these negative wants soon come to be associated with those concrete things which alleviate them--in the same way in which we come to like good-tasting food whether we are hungry or not. Now chief among these acquired goods-in-themselves is, quite naturally, that one of them which is invariably present when the negative needs are administered to. I refer, of course, to the person by whom the comfort is brought, usually the mother or nurse. And this person, as the child soon discovers, is no automaton. (If she were, the life-history of culture would be briefly told.) She is a person of inexplicable moods--though later on the moods come to be somewhat more predictable. But from a child's-eye view, how is one to tell whether one's next move will be greeted with a smile or a "no-no"? with a kiss or a cuff? And this matter is all important to the child.

Both psychologists and people of common sense have tended to take this desire for approval for granted, as something "natural." But there is nothing natural about it. It springs from two sources, both of which represent primary needs. One is the direct association of reproof with physical punishment. The other, also acquired, is the fear of loss of the ministrations of the indispensable mother. For an approving mother is the old familiar person who has so long contributed to his comfort, while a disapproving mother is essentially a withdrawing one, as well as a strange one; the disapproval carries with it a definite threat to the old-time peace and stability.

The equation "mother equals physical comfort" has long since been written in the nervous system of the child who is learning to respond to praise and reproof, so that the mere presence of mother is a good in itself. But that equation is now seen to be inaccurate, and with further experience he must have recourse to a higher mathematics. Two new equations therefore take the place of the former one: approving mother equals physical comfort; and disapproving mother equals loss of physical comfort. If all this seems to you to make of the child little more than a selfish and scheming brat, I shall have to congratulate you on your perspicacity, for even at his most lovable that is just what he is.

The consequences of this can scarcely be other than those of conflict for the child, and this conflict is of the greatest importance for both culture and personality. But it is a conflict, in most cases, between two unequal forces. While the outcome is predictable, in a statistical sense, the method by which the outcome is achieved is not predictable. Thus it is almost a foregone conclusion that a child brought up in our society will eat apple pie (if he eats it at all) with a fork, at the end of a meal, and without making too much noise with his mouth. He does this because it has been the path of least resistance by way of satisfying his bodily needs, under a given set of cultural conditions. But the kind of personality characteristics which he has developed in conforming to these and other requirements is not a foregone conclusion. Hence we have individual differences and unique personalities.

I am not suggesting of course that different methods of adaptation to the strains and stresses of cultural requirements are the only cause of personality differences. The adaptations are made by organisms which have already developed differently because of different hereditary beginnings. But the function of the hereditary forces, briefly stated, are always those of a limiting nature: hereditary conditions may say, "Thou shalt not," but never, "Thou shalt." The actual characteristics of any personality are always developed in response to environmental forces (meaning chiefly cultural ones) within limits set by hereditary conditions. These hereditary limits, of course, also have a very great deal to do with individual differences in personality.

We are now in a better position to get a perspective of the process of acculturation. The fact that a child is brought up in a given culture, and not in a void, means that he is permitted to look at most of the objects and events around him from only a certain point of view. Thus, if one is a Moslem, a pig is not merely a certain obese quadruped, but a symbol of contempt and perhaps of temptation. If one is a southern-born American, a Negro is not merely a heavily pigmented human, but a superior sort of automatic washing-machine, etc.

Culture is a pair of many-prismed spectacles, providing a specified range of vision for every object that is viewed. It is clapped on the child's eyes almost at birth, and few there be who shift or remove the prisms. Acculturation is the process of learning to use the spectacles. Their use is dually enforced by social pressures and by our demands to satisfy our own needs. If, in this figure of speech, to be human is to be possessed of vision, we should be blind without the spectacles.

The implication of this, of course, is that human-ness is something acquired from one's environment. There is but one alternative to this understanding of the word "human," namely, that our bodies are differently constructed from those of other living creatures. The latter statement, of course, is true, and without these specifically human biological characteristics (particularly those associated with speech) we should not be able to acquire a culture and become human. Human-ness, in other words, demands <u>both</u> a set of biological characteristics, and a culture. The <u>antecedent</u> biological conditions say, in effect, "You <u>may</u> acquire human-ness, under certain environmental conditions." The cultural conditions say, "If you have the requisite biological conditions, you <u>must</u> develop human-ness." That which is commonly understood by the word "human" is necessarily acquired through culture.

There is an exceedingly important corrolary to this. None of us owes our human-ness to culture-in-general. Each of us grows up in a <u>particular</u> culture. In spite of certain "patriotic" doctrines to the contrary, all known cultures are about equally good for the purpose of developing human-ness, but nevertheless they are all different. Since most of us participate in but one of them, it thus results that in spite of our recent much-vaunted facilities of communication, most of us are quite oblivious to the existence of other cultures. I do not mean, of course, that we do not know that they exist, in the sense that we could answer questions at the end of the chapter in the geography text. But our own culture is far more deeply imbedded than that. As I have tried to say, so adapted have our perceptive processes become that all interpretations but one are shut out at that source. Our particular interpretation of the object or event seems to us to inhere in the object or the event itself; it seems to have objective status.

The corrolary is simply this: human-ness, which actually does emerge step by step with culture, comes almost universally to be identified with my particular culture. Do I observe that adults tend to limit their sexual attentions to a single mate? Then I conclude that it is human nature (rather than the nature of my culture) to be monogamous. Have I noticed that nearly every one seeks to acquire material possessions? Then of course possessiveness is rooted in human nature. Does recorded history (that is, of course, the history which falls within our own tradition) tell a story of almost uninterrupted wars? What is simpler, therefore (or more erroneous) than to conclude that it is human nature to go to war?

If we take the limited point of view that whatever customs have become imbedded in the nervous systems of a given group of humans at a given time represent human nature, very well. In that case human nature is monogamous and polygamous and polyandrous; it is possessive and sublimely indifferent to material possessions; it is warlike and conciliatory. If human nature is to be defined in terms of culture it is all of these things at diverse times and places. If it is to be defined in terms of the least common biological denominator, then it is none of them, for biological conditions dictate only limitations (thou shalt not's) and never specifications (thou shalt's). In either case human nature is no one of these things rather than its opposite.

Such are the conclusions which emerge from a consideration of the process by which individuals acquire culture. One other conclusion is also suggested, and it needs to be examined. I have already suggested that culture tends to persist, that it appears to have a momentum of its own. Is this due to characteristics of individuals? Since culture, at any given moment, resides in the nervous systems of individuals, and since nervous systems (particularly those of adults) are notoriously resistant to change, would this not account for the slowness of historical change? And does not this therefore imply the "inevitableness of gradualism" as the necessary tempo of social change? It all seems very simple and logical, but the answer comes out wrong.

The fallacy involved is, as a matter of fact, precisely that which I have just mentioned. Resistance to change may itself be a consequence of a particular culture rather than a biological necessity. If human nature were inherently resistant to change there would be no need of the multiplicity of sanctions which surround all approved ways of behaving. The very fact that in spite of rigid reinforcements--e.g., law, religion, social pressure, etc., etc.,--customs do change, and sometimes very rapidly, is clear evidence that there is no preponderance in human nature of a tendency to go on doing the same thing, over the opposite tendency. Tendency to seek the new and different is, indeed, as characteristic of humans as tendency to continue old and familiar ways.

There is, moreover, another reason why we may not ascribe resistence to change to human nature. There is hardly a phase of any given culture which does not serve the peculiar interests of some one or more groups within it. Social change, therefore, is no matter of mere academic interest to such groups, and of course it is no accident that almost any proposed change meets the active opposition of interested groups. This is the more true, of course, in highly complex cultures such as our own. Pressures of vested interests are a significant part of the recorded history of all social groups, from primitive priest-crafts to the modern industrial corporation.

Such braking effects upon cultural changes which would otherwise occur have been immensely speeded up during the industrial era, precisely because the increasing tempo of technological advance has increased the number of cultural changes which seem desirable to those who have no vested interest in the status quo. Indeed, nothing is more characteristic of our own epoch than the pervasiveness of contemporary propaganda. I think there will be few to quarrel with me when I say that the huge preponderance of recent propaganda, in our own and most other countries, has been precisely this nature. That is, it serves to strengthen our resistance to change of some sort. For you must remember that propaganda (except under conditions of complete censorship) is in essence that which is not labelled as such; there is no convenient "advt." placed at the end. And of course the reason why we so frequently fail to recognize it is just because some present custom, which we take for granted anyhow, is lauded or defended against possible encroachment.

To put the matter somewhat differently, exhortation toward cultural change is immediately suspect, and therefore relatively ineffective, whereas the extolling of things as they are is simply accepted as self-evident truth and so fulfills its purpose perfectly. We can only speculate as to how much resistance to change there would be in the absence of any propaganda, or other deliverate pressure, by vested interests. But regardless of the exact answer, it is plain that existing resistance to change can not be assigned to any inherent tendency in the human animal. It is a carefully nurtured tendency. It is, in short, an aspect of culture rather than of biological disposition.

Let me be more explicit, as I do not wish to be misunderstood on a vital question. It would be absurd to maintain that there is no stability in the human nervous system. Of course it is true that long ingrained habits tend to persist under certain conditions. And those conditions provide the crux of the whole matter. The conditions are that the external situation remain the same, or essentially so. A man who has eaten mush and milk for breakfast for thirty years may be said to be addicted to the habit, and under the same set of external conditions will resist change. But let conditions be so changed that he is free to shift to a menu of ham and eggs, and no resistance to change will be offered. Of course no one would want to change his habits if the external equilibrium were not so upset as to render another alternative more attractive.

Just so, the sluggishness of cultural change would be a matter of no concern if the social equilibrium had not been upset. There is no need of propaganda by vested interests in a stable society in which neither interpenetration with other cultures nor technological changes have introduced the need for accommodating changes in customs. To state the earlier conclusion somewhat more carefully, then, there is no such thing as a tendency within the human nervous system to cling to old, established habits under changed conditions. It is true that the feeble-minded and certain types of insane patients tend to repeat old ways under new conditions. It is also true that children can adapt themselves to some types of changed conditions more readily than adults. But the fact remains that man is an adaptive animal, and apart from cultural pressures against change, he prefers to modify his behavior when it is to his advantage to do so.

Mr. Jones has made it clear that much of the _malaise_ of our time is due to the failure of some of our customs to adapt themselves to the needs of a rather new technological culture. I do not conceive it as my task to try to create in you an easy optimism about changing those customs. It will not be easy, and the adjustments will of course never be perfect. But I do conceive it as my task to tell you that, insofar as I can learn from all the psychological lore at my disposal, the difficulties do not lie in individual human nature. Changes in individual human beings can be _produced_, providing that cultural pressures against change are so reduced as to modify the conditions under which children are brought up. There are many obstacles involved, but the obstacles are not primarily biological, but cultural.

MEDICINE AND SCIENCE

Dr. Wilmoth Osborne

If you hear the rattle of bones it is the skeleton of Devils drying in the closet. If you smell blood it is blood shed in the battles waged by conflicting Dogmas.

"The greatest single advance ever made in controlling disease was not the acquiring of something new but the giving up of something that was old--the discarding of a false belief." So says a scientific writer of today who states that the belief in supernatural causes of disease rather than natural ones held back the progress of medicine for thousands of years. A true belief is a "true guide to action"--a "recipe for action". If in medical history the use of the scientific method has improved the welfare of mankind by reducing illness and preventing disease thus lengthening the span of life, then are we not justified in calling the scientific method a true guide for action? The scientific method shuts no doors on any phenomenon of life and death and has contributed most understanding of these phenomena. The history of medicine shows many false beliefs and in actual practice in this so-called "scientific age" still is retarded and runs into dead ends by the clinging of magic, superstitions and controlled philosophies which leave no room for change or growth in the development of knowledge. I trust it is unnecessary to point out in passing that I use the words true and false above, in the only sense that science ever uses these terms--i. e., a doctrine is false when it does not conform to the empirical observations of qualified observers and vice versa.

The story of medicine runs through all records of former society and disease itself is older than man. Dinosaur bones leave records of infection before man lived to make tell-tale signs of his ills. On the walls of the caves of the Cro-Magnon man there is a picture of what corresponds to "medicine man", the doctor of primitive peoples. The code of Hammurabi 2000 B. C. records for us that doctors were even then an "organized body of men with scales of fees for particular services to man and beast". Medicine, the healing art and science, has been a continuous cultural red thread running through the material of social human growth and makes an excellent study for understanding both science and culture as defined in previous discussions of this series. The accumulated knowledge of medicine not only is a part of the culture of society but also affects the culture and in turn is affected in application by other phases of that culture and their interrelations. The relationship is reflected in the state of public health. Public health reflects the application or use of scientific medicine as well as the belief in magic, superstitions and demons. The wish for health and strength keeps magic alive as well as furnishes the authority for the application of scientific medicine. Whether a scientific hypothesis proves correct or not is often a matter of life and death and in the end the fear of death invites the healer who can really heal and prolong life. Those of you who saw the Life of Pasteur film remember the excellent example given there of this very point. Pasteur was given sanction to try his serum for the cure of rabies on the little boy only because the mother and physicians knew death was certain without trial. They did not believe in the effectiveness of the serum or its underlying principles, but they believed more in the inevitability of death.

Although all former cultures have influenced the growth of medical science, it was not until the dogma of traditional hand-me-down authority was overthrown for the authority of the scientific method based on observation, hypothesis, experimentation and rechecking of results that we have made measurable gain. At every stage, scientific medicine has had to win its way against the authority of custom and prejudice.

The Greeks came nearer to the modern approach in medical science than any other culture of which we have record. "Greek medicine culminated in the school of Hippocrates 420 B. C. with a theory and practice of the art somewhat resembling those which are current today, and far in advance of the ideas of any intervening epoch till modern times are approached. Their physiology, unlike that of Aristotle and Galen, was not concerned with final causes; it dealt more with how than why, and was thus modern in spirit. The use of experiment appears: for instance, the Hippocratic writer concerned with embryology advises the observer to open hens' eggs day by day as incubation proceeds. Disease was reckoned as a process subject to natural laws. The insistence on minute observation and careful interpretation of symptoms pointed the way to modern clinical medicine, while many diseases were accurately described and appropriate treatment indicated." (Dampier - History of Science, p. 29).

Unfortunately, the scientific spirit of the Greeks lost its influence on medicine. It was the Roman, Galen, 129-200 A. D., who dominated medical learning for 1400 years. "'He systematized Greek anatomical and medical knowledge and united the divided schools of medicine.' But it was for dogmas deduced with great dialectic skill from untested theories, and for the authority with which he expounded them, that he became famous, and not for his observations and experiments, or his practical skill. This theistic attitude of mind appealed both to Christendom and Islam, and partly explains his great and lasting influence." (Dampier) During the middle ages there was much concentration on preparation for life after death and this made men indifferent to conditions of living in this world. Some one has said, "In this unfavorable medium for its growth science was simply disregarded, not in any hostile spirit, but as unnecessary."

Vesalius (1515-1564) often called the "Father of Anatomy", revived the scientific study of medicine. He was ostracized, snubbed, and ridiculed because he dared to contradict Galen. Vesalius taught at Padua and published a book on human anatomy based on actual numerous dissections of the human body and thus discredited the authority of Galen, whose dissections had been almost entirely on animals yet whose teachings dominated the study of human anatomy over 1000 years. Harvey, English physician (1578-1657) too dared to observe and make actual anatomical studies of repeated observations, dissections and experiments on human and animal hearts and by the publication of his book on the circulation of the blood through the heart showed Galen's concepts of physiology false.

In the 17th century we begin to see a more rapid enlargement of the scientific snowball which up to now had been rolling about picking up a new bit of clean snow here and there but more often almost completely destroyed or reduced to dirty ice by the pressure of dogmas, witchcraft and superstitions which flourished. The Royal Society of London for Promoting Natural Knowledge was chartered by Charles II in 1662, and in France in 1666 the corresponding Academie des Sciences was founded by Louis XIV. "Their influence in securing adequate discussion, focussing scientific opinion, and in making known the researches of their members has had much to do with the rapid growth of science since their foundation, especially as most of them soon began to issue periodical publications." (Dampier 164). But although Charles II chartered the Royal Society, he also practised the laying-on-of-hands to cure the disease known then as the King's Evil, scrofula, and to us as tuberculosis of the glands of the neck. The kingly touch was potent, for Edward the Confessor in England touched for this disease in the 11th century and the practice continued into the 18th century when Louis XVI "touched" 2400 sick persons on the day of his coronation. This potency of touch has now passed from Royal hands to foot and spine manipulators, and we are still comforted by Divine blessings and amulets. The treatment of disease ran far behind the knowledge of the day, as it still does throughout the world. The first London Pharmacopoeia, printed in 1618, illustrates the transitional state of medicine at that time: Quinine and mercury salts were listed among the 2000 remedies, as well as "pills made of viper flesh, dried lungs of foxes for shortness of breath, ground up jewels, oil squeezed from bricks, bear grease to grow hair, and snake oil to limber muscles, moss scraped from the skull of a convict hanged in chains (a popular remedy), crabs' eyes, hoofs of animals, fly specks, the dung of many different kinds of animals (crocodile dung was especially beneficial), human sweat, saliva, spiders' webs, snake skins, lice, oil of puppies boiled with earth worms, and cat-fat ointment!" (Haggard, pp. 268-269). But although the microscope was not being used to diagnose the state of the pathology of the tissues or the type of bacteria causing disease because no one had yet gone this far on the road of medical knowledge, yet the microscope had been discovered and mathematical measurements were beginning to be applied to physiological functions. These two steps were most important tools in the development of scientific medicine.

Four years after the Pilgrims landed at Plymouth, a man was born in England who later took a most important step which led to better understanding and practice of medicine. Thomas Sydenham studied diseases as distinct entities and although specific causes were not known he described symptoms in their chain of sequence and associated each sequence with a separate disease.

In the 17th century the first blast was put under the theory of spontaneous generation by Redi (1626-1679) who showed that if flies and insects were kept from reaching the flesh of dead animals no grubs or maggots appeared in it, and later his experiment was repeated and verified by Spallanzani (1729-1799) who went a step farther and showed that vigorous boiling destroyed life and if air was kept out no life developed in the materials boiled. This fact was later brought to practical conclusion by Pasteur, who so effectively applied this principle to wine making. Now we drink pasteurized milk (if we don't we should or we are not applying our scientific knowledge to disease prevention).

We jump now in our seven league boots to the 18th and 19th centuries and nod in passing to Morgagni, who at the age 79 published his life's work in the first book of pathology (1761). Just before the beginnings of the Revolutionary war "physicians for the first time learned something of the changes in the body caused by diseases and the symptoms that arose from them." He used no microscope and that link between macroscopic and microscopic appearance of diseased tissues was made by his German pupil Rudolf Virchow in the middle of the 19th century.

We fall on our knees to Edward Jenner, a country practitioner in England, whose respect for observation and experiment led him to discover a way of preventing smallpox from the study of evidence which physicians had refused to consider because they thought it improbable. He published in 1798 a book only 75 pages in length but it is one of the great masterpieces in medical literature. It was called "An Inquiry into the Causes and Effects of the Variolae Vaccinae",--smallpox to you.

Haggard - "The Doctor in History", pp. 322-323: "A tradition among the dairy folks of the countryside led him to make his discovery. Now and again Jenner was called to inoculate against smallpox the members of some farmer's family. And often he could not succeed in giving the smallpox in this way to people who handled cows. 'They've had the cowpox', said the farmers. That was the tradition. Those who had the disease called cowpox would never afterwards take the smallpox.

"Cowpox appeared in the dairy cattle as small pus-filled sores on the skin. Men and girls handling the cattle sometimes acquired similar sores. Beyond the local effect which lasted only a short time, they were not ill. And yet tradition insisted that those who had had the cowpox never took the smallpox.

"Here to Jenner was a thrilling possibility--something safe and simple to take the place of inoculation. But he had learned from John Hunter the principles of science. He could not jump at conclusions; he must obtain proof by experiment.

"In 1796 cowpox broke out on a farm in Gloucestershire; a dairy maid named Sarah Nelmes contracted the disease. Jenner took from her sores a tiny drop of pus and put it in a scratch on the arm of an eight-year-old boy named James Phipps. Soon a small sore appeared on the boy's arm; he had the mark of cowpox only in that one place.

it healed and left a tiny scar. Jenner waited. A month went by and then he again made a small scratch on the boy's arm; this time he rubbed over it the pus from the sores of a man with smallpox--he inoculated the boy. James did not become ill. Again a few months later Jenner inoculated him and still he did not take the smallpox. The tradition was true; cowpox protected against smallpox. Jenner wrote an account of his experiment and sent it to the Royal Society for publication in the "Transactions". His letter was returned unpublished. The observation, the members of the Society thought, was too amazing to be true. It was a mere chance that James had not taken the smallpox.

"Encouraged by John Hunter, Jenner repeated his experiment on other subjects. He got the same result: cowpox protected against smallpox."

Although Jenner knew nothing of bacterial infection as we now know it, by the use of observation and experiment he established for all time the "validity of vaccination" and the beginnings of our knowledge of immunology.

Jenner published his work 139 years ago and we seldom now hear of a smallpox death or see a pox-marked face; yet only six years ago (1931) here in Bennington there was an epidemic (87 cases) which threatened lives and beauty; and some people still fight the principle of vaccination and laws designed to stamp out disease.

We take off our hats to Claude Bernard (1813-1878), French physiologist, who is called the Father of Experimental Medicine. He developed physiology as a positive science and left some fundamental observations on the function of the liver and the secretions of the pancreas which were the beginnings and led into what we now know about the causes and treatment of the disease diabetes and other diseases produced by the endocrine glands. The other basic contribution he made was the role of the vaso-motor nerves or the involuntary nervous system.

To Louis Pasteur (1822-1895), a mere chemist, we erect monuments dedicated to the science of disease prevention, and acclaim a moving picture depicting a fairly true story of his dramatic life work one of the greatest movies of 1936. His genius for picking up all the threads of scientific knowledge in his day and weaving them together into a pattern of applied science has never been surpassed. You will remember the antagonism which Pasteur had to face from the physicians whose prejudices were undermined by his discoveries. The establishment of bacteria as microscopic organisms causing fermentation and disease laid the ground work for Lister. The contributions to disease prevention of Jenner, Pasteur, Koch, and Lister, each pursuing the scientific method, and the effects they produced on subsequent scientific workers toward the saving and prolongation of life, are too widespread for comprehension.

We cannot fail to honor the United States and the dental profession in this sketchy survey of scientific medicine, because they contributed the application of anaesthesia for surgical use without which Lister's antiseptic principle helped little. A dentist, Horace Wells of Hartford, Connecticut, discovered the use of nitrous oxide or gas anaethesia, but it took his friend William Morton, a dentist and Harvard medical student, to experiment sufficiently to prove the value.

I read from Haggard - "The Doctor in History", p. 346 - "The story of that demonstration has become one of the classics of medicine. Rumor spread that some medical student had presumed to offer a method of abolishing the pain of operation. The gallery of the operating amphitheater was crowded with incredulous spectators. The patient was brought in. The surgeon waited, dressed in formal morning clothes--in those days surgeons did not wear white gowns, nor did they wash their hands before operating, but only afterward, for Lister had not yet shown that infection might come from dirty hands. At the appointed time the surgeon, the patient, the strong men to hold him down in his struggles, the spectators, were all ready, but Morton was not present. A quarter of an hour passed, and then Dr. Warren, taking his knife in hand, turned to the spectators and said, 'As Dr. Morton has not arrived, I presume he is otherwise engaged.' The audience smiled--they had been skeptical all along. Dr. Warren touched his knife to the skin of the shrinking patient. At that moment--so the story goes--the door opened and in came Morton. He had been delayed in completing an apparatus to administer the ether. Dr. Warren stepped back, pointed to the man strapped to the operating table, and said, 'Well, sir, your patient is ready.' Amid the silence of the spectators, surrounded by unsympathetic faces, Morton administered the ether. In a few minutes he looked up and said, 'Dr. Warren, <u>your</u> patient is ready.' The incredulous audience watched in silence as the operation was begun. The patient gave no sign of pain; he was obviously alive--everyone could see his breathing; he slept. With the completion of the operation, Dr. Warren turned to the spectators, and said, 'Gentlemen, this is no humbug.'"

I cannot withdraw from this pinpoint peep into the development of the healing art and science without mentioning Pinel, the French physician who was the first to recognize that mental ill health was due to natural causes and not to demons and devils. "Under his influence the prison asylums of Paris, the Bicètre and the Salpetrière, became hospitals." The workings of the mind too are subject to scientific investigation although one of the last strongholds against approach by the scientific method. This is due to the fact that man's fear of the unknown caused him to build up the defense that the mind was omnipotent and untouchable.

When one glances back through the ages and thinks of the epidemics of plague, cholera, smallpox, typhoid and typhus; the thousands of death due to tuberculosis, leprosy, malaria, yellow fever, diphtheria, dysentery, tetanus, and syphilis, and today thinks of the phalanx of medical science and disease control needed to cope not only with these enemies but all the diseases due to poisons, faulty nutrition, accident, etc., it is staggering, to say the least. Disease has not been conquered and never will if we think of disease as a resultant process of life phenomena growing out of the struggles of existence for various forms of life. "Nature seems to have intended that her creatures feed upon one another."

But if we grant the superiority of man in intelligence over other forms of life and believe that in the evolution of that intelligence man has acquired sufficient knowledge about some of the life forces to be able to control and utilize a small fraction of these forces for his benefit (proof--increase in life span), then we have to decide if any method has produced greater results than another and continue to apply that. Here we say in medical history there is proof that the scientific method has been most effective. We go one step further and say the greatest hindrance today of improved control of disease is the inability of man to work together cooperatively on a rational basis.

We know much more about health control than we can put into practice. Human life is wasted unnecessarily--in peace as in war. The blocks in this direction are due to many cultural factors over which man has not yet learned control, but this does not mean he is not learning or never will. There has been greater cooperation nationally and internationally over the prevention of epidemics than any other one cultural factor even if lives are saved from typhus or cholera one day only to be shot down the next by a bullet. Zinsser tells us that "during the most turbulent period of the Russian Revolution, the only official relationship which existed between that unfortunate country and the rest of Europe consisted in the interchange of information bearing on the prevention of epidemic disease, arranged in cooperation by the Health Commission of the League of Nations and the Soviet government."

The two main differences which characterize modern scientific medicine today from previous ages are: (1) the increase in knowledge about the phenomena of disease--this being due to the pooling of knowledge and concerted efforts of all men pursuing the scientific method (not medical men alone), and (2) the reapplication of this pooled knowledge toward attempted prevention of disease by control of the <u>natural</u> forces involved. Early man attempted control by propitiation of the gods or driving out the devils. This was attempted control of <u>supernatural</u> forces. No one has yet shown the limits of improvability of a group of human beings under optimal conditions, that is, conditions considered the most favorable for human growth and welfare. Man will first have to agree as to what are optimal conditions and then set about by the scientific method to prove the hypothesis. Surely we have enough scientific knowledge at our disposal to begin. Judging from medical history in all cultures, belief in the scientific method would seem a "true belief".

THE GROWTH OF POPULATION

Barbara Jones

In suggesting that modern medicine has had some effect upon our present culture, Dr. Osborne has been far too modest. She has told you about the growth of medical knowledge; I shall try to show you some of the results of its application. When you have considered the facts of population growth in the last 150 years, I think you will agree with me that we are in a peculiar sense dependent on scientific medicine; and this for the excellent reason that without it none of us would have been born. You may accuse me of exaggeration: there would obviously have been some population today, even though a much smaller one, and some of us might have appeared on the scene. I think it quite unlikely that the particular combinations of genes which form the bases of our admirable personalities would ever have come together; a large proportion of the 18th-century people who were our great-great-grandparents would have died in infancy, with the distressing result that neither our great-grandparents, our grandparents, our parents, nor we ourselves would have been brought into the world.

I want to call to your attention two biological facts, sadly neglected by historians, which seem to me to be basic to an understanding of our culture. One is the enormous and unprecedented growth in numbers in the 19th century; the other is the increase in the length of individual human lives. Both can be clearly traced to the application to human affairs of the scientific knowledge the development of which has just been sketched by Dr. Osborne.

Though modern culture generally refers to Western European culture and its extensions, I shall use only the population figures of England and the United States. The English figures are particularly illuminating, because fairly reliable estimates go back as far as 1100 and because England is an island, with definite boundaries, so that we know we are talking about the same geographical and political unit throughout. The changes which occurred in England are typical, though the rates of growth in other countries, for example Germany, started to increase a little later than in England, which was earlier affected by the scientific developments.

Look at Chart 1. You will see that it begins about the year 1066, when a census of landed property was taken by the Norman Conqueror. From this census, the Domesday Book, it is estimated that the population of England was about $1\frac{1}{2}$ million. The shape of the chart indicates a slow, steady rate of growth until about the beginning of the 18th century. The population doubled itself in about 400 years--an almost imperceptible rate of growth from generation to generation. Now look at the record of the last 150 years, and you will see why I say that the modern period is radically different from those which went before. We should remember its youth before we judge it too harshly.

A glance at this second chart will bring you up to date, and perhaps exorcise the bogeys of overpopulation or race suicide, whichever may be haunting you. The steep 19th-century curve of rapid increase is flattening out, and we are approaching a period of stability, followed probably by some decline. These are the American figures, the dotted lines representing various estimates for future growth. The general shape of the curve is similar for England, though the English population has already approached nearer to the flat part of the curve, and stability is expected within the next decade.

How are we to explain the enormous upswing in numbers? Evidently we must look for an explanation in the conditions of life in 18th-century England, where the growth began. The Technocrats, among the few writers who have given the matter some of the attention it deserves, attribute it to the harnessing of power. The human race suddenly fell heir to the stored-up energy of the sun in the form of coal, and no longer had to depend on the daily stint of energy derived directly from the sun's rays. Other writers have called us children of the machine, and have drawn more or less startling conclusions from this putative relationship. But both the harnessing of power and the invention and use of machines require explanation. The social historian goes much farther back and farther afield, and finds a great number of interacting factors responsible alike for the machine, the use of power in production, and the growth of numbers in 18th-century England. These factors could be grouped under two main categories, the growth of knowledge and the growth of wealth. These are by no means independent phenomena, for it will be found that the free enquiring spirit which led to the development of modern science, and the adventurous spirit of merchants and traders which led to the discovery of the New World, flourished together in the busy centers of Mediterranean commerce at the end of the mediaeval period in Italy. After the discovery of America, Holland emerged as a center of trade and intellectual activity in the 16th and 17th centuries. England, in the main channel of commerce between the old world and the new, became the center of social change, and the cradle of that particular combination of social changes later called the Industrial Revolution, in the 18th century.

These general causes can throw very little light on the question of population growth, unless we know exactly how they affected birth- and death-rates. Perhaps I need not remind you that populations grow when the birth-rate exceeds the death-rate, decline when more people die than are born, and remain stationary when birth- and death-rates balance one another. Malthus, writing about this point, when numbers were very much smaller than they are today, issued grave warnings against the "devastating torrent of children". One might therefore suppose that babies were pouring into the world at an unprecedented rate. Indeed, many people seem satisfied to believe that the new factories exerted an economic demand for workers which automatically produced the desired biological results. Actually, there is no evidence of an increased birth-rate. Throughout this long period of comparative stability, the fertility of marriages was unchecked, and resulted in a birth-rate of about 35 per thousand. Numbers were kept down, not by restrictions on birth, but by a death-rate almost as high as the birth-rate. Adam Smith, writing in 1776, remarks that "it is not uncommon in the Highlands of Scotland for a mother who has borne twenty children not to have two alive". Smallpox was called "the poor man's friend, who happens to be burdened with too many children". It was the reduction in the death-rate in the second half of the 18th century which initiated the enormous increase in population in the 19th. The change became apparent about 1750. The death-rate continued to decline until about 1830, while the birth-rate remained substantially unchanged. Evidently, once the death-rate has been brought below the birth-rate, growth will continue until some further change in the two rates occurs.

The crucial decline in the death-rate in the latter half of the 18th century has been too often attributed solely to the revolution in industrial production. No-one has adequately explained the interrelationships of population growth, once it starts, and the progress of invention and industrial advance. That there is a reciprocal relationship cannot be doubted. But if you look at the dates on these charts, you will see that the death-rate declined before the application of steam power to industrial production had transformed the material basis of life. Contrary to the general impression, which emphasizes the mechanical arts, it was an improvement in the arts of medicine and agriculture, based on the biological sciences, which began the transformation of our social heritage, and ushered in the so-called Machine Age.

I shall deal only very briefly with the changes in agriculture, which so significantly improved the diet and health of the English people during the 18th century. Like much that was vital in English life, the improved methods were introduced from busy, commercial Holland. Most of the capital, much of the enterprising spirit and the willingness to break away from traditional methods came from the rising class of merchants and traders. Marshes were drained, fields were enclosed, new methods of cultivation and rotation of crops were developed, stock breeding was enormously improved, and the introduction of root crops revolutionized the food supply. It is hard for us to realize the meagreness and uncertainty of the diet of our forefathers. Throughout this long period of relative stability, famine was an ever-present menace. The traditional open-field agriculture which had persisted almost unchanged for centuries afforded only a very small margin of safety in years of good harvest. Cattle eked out a meagre and mangy existence on the commons, interbreeding indiscriminately, and with poor genetic results. Every autumn a drastic slaughter of these miserable beasts was necessary, because only a small supply of natural hay was available for winter fodder. Consequently most of the people could buy only salted meat in winter. The inadequacy of the diet is clearly reflected in the prevalence of deficiency diseases. Rickets and scurvy took a heavy toll throughout this period. By the end of the 18th century, these two scourges had been very much reduced, and improved crops, together with improved transportation, had almost eliminated the danger of famine.

Man, like any other biological species, is dependent on an adequate food supply. Clearly, our great-great-grandfathers might have died in infancy, or at least before they had had time to start the chain of generation which ultimately produced us, had the traditional methods of agriculture remained unchanged. But their early cutting off would have been no less certain without the simultaneous changes in the arts of medicine and hygiene. Again, it was no sudden eruption of inspired inventions which made the difference. Rather, it was the application to everyday life of the new knowledge; and the knowledge which was applied came through the same channels in the cases of both medicine and agriculture: the ferment began in the Italian cities, reaching England through Holland. The influence which transformed English medicine was the teaching of Herman Boerhaave, himself educated at Padua, who had founded a medical school at Leyden at the end of the 17th century. No great theoretical discoveries are associated with his name. His importance lies in the fact that he established for the first time the clinical instruction of medicine, setting up for that purpose a medical school with a hospital attached. Some of his students founded the Edinburgh school of medicine on similar lines in 1725. From these centers of medical instruction spread the spirit of practical, experimental, scientific interest in treating and preventing sickness, which sent men forth to wage an unremitting attack on traditionalism, prejudice, superstition, ignorance and dirt.

Except for the immunization against smallpox already described by Dr. Osborne, most of the advances made by this new race of doctors were in the fields of personal and public hygiene. In both fields, they found plenty to do. By modern standards, our ancestors would be judged unattractive both to the eye and the nose. They lived in conditions which must have been remarkably favorable to disease germs of every kind. Linen garments were rare luxuries, and cotton was not available till after the revolution in textile machinery. Woollen clothes were worn, day and night, year in and year out, and never washed. Indeed, washing, except for the face and hands, was not customary even in respectable circles. The 18th-century doctors had great difficulty in persuading mothers to wash babies or change their clothes; the nurses were afraid that such a procedure would rob the infants of nourishing vital juices. To enter a hospital or a gaol, or even a court where prisoners were being tried, was to invite death from typhus. Lillias Dulles brought me a pamphlet from London, printed in 1784, in which one Thomas Day calls the attention of the worshipful justices of the peace to the conditions in Maidstone Gaol: he points out that "at the last assizes eleven bills were found against prisoners in such a bad state of health that they could not take their trials; and it is a fact, that two prisoners were expiring, whilst the grand jury were examining their indictments, and were actually dead before the bills were returned to court. During the last ten months, fourteen prisoners have died of the small pox, and gaol distemper, of whom several were persons unconvicted of any crime".

Typical achievements of 18th-century medicine were the establishment of maternity hospitals; the formulation of rules for the hygienic conduct of hospitals and gaols; great improvements in sick-room nursing, and in the feeding and care of infants; and a very considerable cleaning up of the incredibly filthy conditions of life in the towns.

A significant part was played in the general improvement by the army and navy physicians, who had both the incentive and the authority to formulate and enforce rules of public hygiene. Scurvy was recognized as a deficiency disease by the navy surgeon Lind, who write a book on the diseases of seamen in 1757. His successor, Sir Gilbert Blane, issued an ordinance commanding a daily ration of lemon juice for all

British sailors, in 1795. The startling results can be easily measured: in 1779, the Channel Fleet was obliged to put into port after a cruise of ten weeks, in order to put ashore 2400 men ill of scurvy. This was by no means a bad record, and you will readily imagine the difficulty of long sea voyages when you consider this appalling loss. In 1800, after Blane's order had gone into effect, the Fleet was able to keep at sea for four months, and then had only 16 hospital cases from all causes. I have always doubted the claim that the Battle of Waterloo was won on the playing fields of Eton, but I am convinced that Nelson's victory at Trafalgar must be attributed to the ration of lemon juice, which made possible long manoeuvers, and the manning of ships with experienced seamen. Probably this same ration of lemon juice is responsible for the designation of Englishmen as "limeys".

I have not time to give you any adequate picture of the work of the 18th-century doctors. You can form some idea of their influence when I tell you that in the 17th and all previous centuries plague, smallpox, dysentery, malaria, typhoid, typhus, rickets and scurvy took continuous toll of human lives. Men were helpless to prevent them or cure them. By the end of the century, many of these were already almost eliminated from England and have ever since been considered as "tropical diseases". The decline in the death-rate which occurred in this period has only been matched in the years since 1870, when the control of communicable disease was put on a scientific basis by Pasteur's discovery of bacterial infection.

The far-reaching social consequences of the sudden increase in numbers are too numerous to mention here. I do urge you to remember the fact of rapid increase, and to take it into consideration when you think hard about human affairs. If you dislike modern life, and yearn for a return to a simpler society, remember that the enormously expanded modern populations cannot maintain themselves without a continued application of scientific techniques. We can do without science only at the cost of drastically reduced numbers; and diminished numbers, however desirable you may think them on aesthetic or misanthropic grounds, are not brought about by a wave of the hand. They result from famine, disease and death, and these in turn are not chosen by human beings. They will occur, if at all, to the accompaniment of violent and long-drawn-out social upheavals.

I believe also that much wisdom would be added to political and historical discussions if historians, politicians, and prophets of doom would look more frequently and with a more imaginative eye at these charts. Perhaps the socio-economic organization of the 19th century, as well as the Weltanschauung of its writers and philosophers, might be better understood if seen as the adaptations of an expanding human society to conditions of rapid growth. In its earlier stages, the expansion was accompanied by great suffering, and social insecurity. The 19th-century synthesis of which Mr. Jones spoke really flourished only in the latter half of the century, especially between 1850 and 1880. The thought and social institutions of this period are likely soon to be recognized as transitory phenomena in human history. It seems to me quite unlikely that the institutions adapted to that stage of growth will work equally well when growth slows down and stops. Our lives, and our children's lives, will almost certainly be lived in a period of great social and political stress, which might be interpreted as an ill-understood attempt to adapt our creaking social machinery to radically altered biological conditions.

The second biological factor I regard as basic to our modern culture is, as I have said, the increase in the length of individual human lives. Dr. Osborne has already reminded you of the recent discoveries of antisepsis and anaesthesia, which made possible modern surgery, and of the revolution in public health which followed Pasteur's discoveries. The net effect can be seen in the reduction in the death-rate from 19.8 per thousand in 1880 to 10.9 per thousand in 1935. No renewed upswing of population growth occurred, because after 1870 a sharp decline in the birth-rate began. This reduction in the birth-rate should probably be regarded as related to these other changes, because it is another example of the intelligent application of advancing knowledge to the improvement of human life. People learned how to limit their familes, and sensibly proceeded to do so. A reversal of the trend towards smaller families will probably come, not from the exhortations of fervid nationalists, but from a change in the conditions of life which cause married people to make the decisions they do about the number of children they want to have. If present trends continue, as seems likely, birth- and death-rates will roughly balance each other again within a few decades, as they did in the earlier period.

The radical difference between the two periods is this: these people lived to an average age probably under 30; modern Americans have an expectancy of life of 60 years, and may extend those years still further if they will adapt their social organization so as to make full use of the medical knowledge already available. The change has been very rapid: as late as 1871 male babies born in England had a life expectancy of just over 41 years. Again, I ask you to think hard about what these figures mean. The fact that the average length of life was under 30 does not of course mean that old people did not abound in these earlier centuries. They did; and I daresay many of the younger ones looked much older because they lost their teeth without benefit of dentistry, were commonly pitted with the smallpox, crooked because of early rickets. It does mean that women spent most of their lives bearing children in horrible conditions of dirt and discomfort, and subsequently burying them. It means that life was constantly threatened by disease, disfigurement, starvation and death. When nature is cruel, and indiscriminately destructive of human life, men too are apt to be cruel and callous, to set a low value on individual lives, and to accept suffering and untimely death as part of the unalterable order of things.

Many of you may dismiss such considerations as basely materialistic, and point to some of the fine intellectual and artistic products of earlier ages. I do not deny the beauty of the mediaeval cathedrals, but ask you to remember what life must have been for most of those who lived in their shadow. Your biological kinship is probably with those obscure, inarticulate people about whom history is silent, who lived and married in ignorance and squalor, at the mercy of natural forces which they could only face with the aid of fatalism and superstition. I am afraid that life for many of them was "poor, nasty, brutish and short".

Though it is not my function as a social scientist to evaluate past and present cultures, I do suggest to those of you who are interested in comparing the general level of human welfare at various times and places, the use of the length of human life as one of your criteria.

When you think about our contemporary culture, I believe you will find it illuminating to consider the consequences of the sudden increase in the length of life. We are an older population than any group of whom we have records. This has all sorts of political and economic implications which I must leave to your imagination. Our attitude towards each other, and towards the universe, is also affected. Our individualism, and the very general belief that the improvement of human life on this earth is a worthy object of moral endeavour, are no doubt related to the increase in the security of our hold on life. We have few children, but expect each one to reach maturity. Many of the evils which our ancestors accepted as part of a supernatural order are now beginning to be regarded as remediable public nuisances, to be attacked by an analysis and removal of their natural causes. When men have learned to control their own birth- and death-rates, it is small wonder that the scientific method which gave them this control should enjoy the prestige which used to belong to the art of magicians and priests who manipulated supernatural forces. I confess that I am so much the creature of my culture that I think it not unreasonable to hope that we can in time learn to control most of the social forces which now threaten to destroy us, by a further use of the scientific method.

Any such hope is likely to be descredited as an expression of "foolish optimism". It is curious that one never hears the phrase, "foolish pessimism". I submit that optimism and pessimism can be equally foolish attitudes, and reflect more accurately the state of the observer's digestion than any condition in the facts observed. I hope that the considerations I have laid before you will encourage you to turn a less jaundiced eye upon human history, to take a longer biological view, and so help to correct the influence of gloomy commentators afflicted with historical myopia.

CHANGED CONCEPTS OF BIOLOGY

Robert H. Woodworth

The doctrine that all plants and animals an complsed of cells was established about a century ago. The modification of this theory resulted in the concept of the cell as the basic unit of life. Some people still hold this idea although there is now abundant evidence which points to unity in the whole organism with the significance of its cellular composition as secondary. Because this point is important I propose to consider it in some detail.

Although cells were seen and sketched by many observers during the 17th and 18th centuries, they were not understood. Almost two hundred years ago Wolff proposed a theory which in essence was the cell theory but this was unappreciated because of the opposition of an illustrious physiologist, Haller, who contended that organisms were composed of "fibers and concrete". Later cells were recognized as an ever present element in tissues of both plants and animals but they were considered to be unimportant.

In 1838 two friends, Schleiden and Schwann, combined the results of their studies and gave to the world the cell theory, They had carefully and extensively studied the tissues of many plants and animals and, although they attached too much importance to the cell wall and were wrong about the mode of development of the cell, they were the first workers to substantiate the fact that all parts of organisms are built of similar units.

It should be stressed that neither of these workers began with the assumption that cells were basic units. They were studying the structure of tissues and an understanding of the fundamental nature of the cell as the unit of organization came after the study of much material. Their conclusion was a result of the application of the scientific method.

The first and most profound modification of the cell theory came as a result of the discovery of protoplasm. About the time that Schleiden and Schwann were studying cells Dujardin, working with the lower animals, described their semi-fluid, jelly-like substance as being endowed with the qualities of life. A decade later Von Mohl observed similar substance in plants and called it protoplasm. It remained for Max Schultze (in 1861) to recognize the identity of the living substance in both plants and animals. Although he made many weighty contributions to microscopical anatomy, his name is now remembered because of his "protoplasm doctrine". In this he showed that the "living cell" was not a "space with walls" but actually a mass of protoplasm without walls.

Further modifications of the cell theory showed the cell to be not merely an element of structure but also a functional unit. Then came recognition that the egg and sperm are modified cells of the parents' body, and later an understanding of the behavior of cells during development from the fertilized egg.

In 1868 dyes came into use for staining cells and in 1883 it was seen that the nucleus, in dividing cells, broke up into a definite number of bodies called chromosomes. These became known as the bearers of hereditary qualities. They are the chief objects of investigation of the whole science of genetics.

The development and modification of the cell theory during the 19th century focused attention on the cell with the result that the organism came to be considered as a group of potentially independent cells which were specialized (structurally and functionally) for mutual benefit. Organisms were thus classified into two great groups, the One-Celled Organisms and the Multicellular Organisms, the accent being on the cell. The cell was the basic unit in biology. The organism was secondary; it was either one-celled or many-celled. Even though this outlook is not now tenable, the cell theory stands second to no theory, with the single exception of organic evolution, in advancing biological science.

It is now recognized that because of the great structural complexity of the protoplasm in the so-called one-celled organisms they are better considered as organisms, non-cellular, and because of the progress since 1900 in the understanding of biologically active substances, the multicellular organisms of the 19th century are better considered as organisms, cellular, the emphasis being on the basis nature of the organism. The biologically active substances mentioned just above are the enzymes, vitamins, and hormones. Such organic materials formed in one part of the plant or animal and carried to another part of the same or a different organism exert some profound effect. For instance, the secretion from the anterior portion of the pituitary gland situated in the center of the base of the brain cavity has a profound effect on the growth of the skeleton. Deficiencies or excesses of this hormone cause abnormalities of many types.

The unity in the organism and the secondary importance of the fact that it is cellular is clearly seen in the development of the fertilized egg. Studies in experimental embryology show that the genes, or hereditary factors in the chromosomes, are of significance in stamping individual characteristics on organisms, thus making them different one from another, but it is the cytoplasm of the egg which determines the genus and species. The egg, before it is fertilized, has a polarity, i.e. a structural organization or rough preformation of the embryo inasmuch as the main axis of the embryo and the arrangement of its first organs are already determined. The small, clear region at the animal pole gives rise to the mesenchyme which forms the skeletal and connective tissue; the next layer, often pigmented, forms the intestinal tract; the lower half of the egg gives rise to the ectoderm.

We see then that organization in the egg is more basis than the cellular nature of the embryo.

Many more examples could be given to show that the organism as a whole is fundamental as a biological unit.

Thus far we have been concerned with the individual organism. What follows pertains more to groups of organisms.

In the 16th century Copernicus and Galileo showed that the earth is not at the center of the universe and motionless, but that it rotates on its axis, and revolves around the sun in company with all the other planets. Their great service was the delivery of the intellect from the notion of a universe created for the purpose of man.

Charles Darwin, 75 years ago, rendered a similar service by his insistance that accidental variations and not purposeful variations (creations) gave rise to variety in organisms. The development of this concept has proved to be the outstanding contribution of biological science, i.e. heredity. I do not propose to dwell here on the principles of heredity. They may easily be found in the literature, while many results of their application are seen in our domestic animals and cultivated plants.

While the theory of organic evolution and the principles of heredity were being formulated, certain ideas proposed in the name of science but unsupported by factual data have crept into useage even though they are highly hypothetical. One of these is the idea that one race of mankind is better than other races. I know of no scientific evidence to uphold this raciocentric viewpoint. Then there is widespread the fantastic belief that sterilization of large numbers of "undesireables" will be some scientific magic bring about a race of supermen. I shall not enlarge on these two points but I will go into some detail concerning a similar notion which is much older. In the last century, descriptive biologists propounded the theory of adaptation of organisms to their environment by structural change. The fact that there are no valid scientific data to support this idea is not generally known. Those who are familiar with the theories of evolution know the extensive role ascribed by some early workers to adaptations of organisms. Others were quick to use this concept as if it were a natural law, with the result that adaptation became a tool in the thinking and reasoning of many intelligent people. The most famous example of adaptation to the environment is that of the blind cave animals. Blind salamanders, blind fishes, and blind insects are all common in caves while such forms are comparatively rare in the open. This fact suggested, but did not prove, that the darkness of the cave was the cause of the degeneration of the eyes.

Now modern studies in the embryology and physiology of the eye show that the cause of degeneration in this organ is a disturbance in the circulation and nutrition of the eye which is independent of the presence or absence of light. So we now know that it was not the cave that made the animals blind but the fact is that animals with a hereditary tendency toward a degeneration of the eyes can not survive in the open. There is an abundance of evidence, experimental and observational, in support of this explanation.

Tropistic responses (reactions brought about in plants and animals by external physical agencies) have likewise been considered to be adaptations to the environment. Plant roots always grow down and away from light. Stems of plants grow upward even in the dark and always grow toward light. Many animals show similar responses i.e. they react to light by moving either toward it or away from it. However, we find that positive phototropism occurs in organisms which have no opportunity to make use of it. Mud-living crustaceans (crustaceans are crabs, shrimp, lobsters, prawn, crayfish, barnacles, water fleas) and caterpillars which live under the bark of trees show this response to light just as strikingly as forms which live in the light. This is now known to be due to the presence of photosensitive substances and the question of adaptation has nothing to do with the production of such chemical compounds in the body. Then again, many organisms show a tropistic response to electrical flow, called galvanotropism. However, this is purely a laboratory product and no animal ever has or ever will be exposed to a constant electrical current except in the laboratory of a scientist. These facts show clearly that tropisms are not necessarily adaptations to the enviromment. Organisms are already adapted to any changed environment in which they can exist. There is no evidence to show that any organism has ever adapted itself structurally to a change in the environment.

It is interesting to note that the environment is as much suited to having organisms live in it, as plants and animals are adapted to living. In fact a critical examination of the environment reveals the fact that in each essential property and certainly in the combination of all, it is quite the best possible environment for life as we know it.

In this instance we have an excellent example of the value of the scientific method in correcting a fallacy produced by intuitive reasoning. We likewise have an excellent example of the persistence in our thinking of errors proposed in the name of science as real relationships.

When it can be proved that a life phenomenon is limited by a simple physical law, there is no longer any need for assuming the action of non-physical agencies. This has been accomplished for a whole group of animal instincts and plant responses; those reactions which determine the relation of the organism to light. They have been and are being reduced to the law of Bunsen and Roscoe (Physiological effect of light is equal to the intensity times the duration of illumination). Some young shoots of plants are so sensitive to light that an amount of light equal to one candle at 250' is sufficient to bring about a bending toward the light source. If two light sources be so placed that one is north of the plant and the other east but twice as intense, the plant does not bend toward the east but toward the resultant of the two light intensities, that is it bends as if a light was placed near the east-north-east position. If two lights be opposite and equal distances from the plant, it grows upright but if one light is of slightly greater intensity the shoot bends toward it. If the light intensities are reversed the plant reverses its bending.

Lower animals behave in a similar way. Larvae of flies can be made to crawl in any desired direction by appropriate adjustments of the light intensities. Some of the caterpillars crawl upward on branches, we think because they want to feed, but they do this because they are phototropic. Undoubtedly they are hungry but the food does not attract them. If placed on a branch denuded of its leaves they crawl up, remain there and starve although there be fresh green leaves on nearby branches. We all know that caterpillars do crawl down but they do this only after they have taken in some food. This reverses the effect of light and instead of being attracted they are repelled by it.

Experiments of this sort demonstrate that these organisms do not react to light because they w ant to nor because they know they will benefit by it, but because they have no choice in the matter.

The effect of temperature on bodily processes has been shown to be precisely like its effect on chemical reactions. Some people object to the tendency toward reducing everything in biology to mathematical formulation or figures. The greatest contribution of biology to science is that of heredity, whose laws would be unknown if it were not for figures. Applied mathematics has been responsible for showing that the laws of chance and not of design or purpose rule in heredity.

Not even the strongest opponent of mechanism would attempt to treat the process of digestion, or that of metabolism, or production of heat or electricity, in any other way than a purely physico-chemical way; nor would anybody attempt to explain the functions of the eye, the ear, or of sensation in the skin from any other standpoint than that of physics.

Biology has been and will continue to be scientific only to the extent that it succeeds in explaining life phenomena by quantitative laws.

We have reviewed the formulation of the cell theory and its modification into what is now called the organismal theory. I have spoken of the phenomenal advancement in the understanding of life processes which has resulted from the application of the scientific method. We know that many of the phenomena of life react according to quantitative laws of physics and chemistry. Most scientific workers suspect that all the reactions of individuals "obey these laws".

Although we do know something about coordinating activities in the body we are still relatively ignorant concerning the activities of the mind. In my opinion the next major contribution to science will come from the field of experimental psychology. These attempts to reduce the workings of the mind to quantitative laws will undoubtedly prove to be as revolting to many people as was the theory of organic evolution in the late 19th century. However, man's great curiosity in understanding himself as completely as is possible will guarantee continued efforts in this endeavor.

It is not possible to predict the reactions of groups of individuals by studying the individual organism. The business of resolving the activities of a culture of organisms to quantitative laws is extremely difficult. New findings from psychological experimentation coupled with the rigid application of the scientific method to studies of groups will produce the most significant advance in all science, i.e. in the new sociology.

Some important work has already been done on the study of cultures of organisms. We are now to hear about such work from Miss Ingraham.

THE SCIENCE OF BACTERIAL CULTURES

Mary A. Ingraham

If I were to ask you "what are bacteria?" most of you would probably answer, "They are very small ...." and you would be quite correct, for they are about a million times as short as man. But if they are a million times as short as a man, they are several million times as long as the atoms of which they and man are composed. Therefore they are large enough to allow for considerable molecular diversity in their composition, but small enough so that our world presents them with innumerable different environments. This room for example provides them with hundreds of distinct cultural opportunities. It is not surprising, considering this great environmental diversity, that countless numbers of different bacterial species have succeeded in establishing themselves in, on and all about us. Indeed, the ubiquity of bacteria is one of their best known characteristics.

Other important bacterial characteristics may also be correlated with the inescapable fact that these organisms are very small. Even in the 17th century when the microscope had been developed to a point where these "narrow engines" could be seen, the magnitude of their activities was not realized. It was not appreciated that just because they were so small, they must possess relatively immense surfaces at which energy exchanges could take place, and that therefore they should be expected to carry on activities of a magnitude incommensurable with their bulk. Doubtless had some important bacterial manifestation such as the souring of milk been a rare phenomenon, it would have received early study. The contagious nature of the decomposition and the associated presence of microscopic organisms would surely have been noted. But milk always soured; it always had; it was the "nature of" milk. In fact it was not until the 1860's that Pasteur succeeded in preventing milk from souring. Only with this technical advance were the problems of bacterial activity visualized in terms which led to fruitful study.

The fact that individual bacteria are very inconspicuous whereas bacterial activities may be most evident has had profound effects upon the development of the science of bacteriology. It is probably for this reason that bacteriology was developed primarily as an applied science. It is also for this reason that we have been led to study bacteria as cultures rather than as individuals. Let me elaborate upon this point:

It is true that we can scrape up a few bacteria, stain them and view the corpses under the microscope, but the results, at best, are apt to be disappointing. We can see so little, little more than a number of dots that either do or do not look round. With suitable techniques we can go so far as to see these dots move, grow, and divide but, with the best of microscopes, we cannot see whether they sour milk, ferment sugar, fix nitrogen or cause diphtheria. Moreover, our methods of chemical and physical analysis are not sufficiently refined to tell us whether, as individuals, bacteria respire, give off heat, produce toxins or do any one of a number of things which we know are done by groups under certain conditions. For technical reasons, then, we are forced to study bacteria not as individuals but as groups growing under specific environmental conditions. Such a group together with the medium in which it exists is known as a culture.

I propose, this evening, to take advantage of the fact that bacteria must be studied primarily as cultures. I shall attempt to contribute to your understanding of science and of culture by giving you a few illustrations of the methods which the bacteriologist has used in studying these organisms and of the concepts of culture which have resulted from his investigations.

You will observe that there are slight differences between the way the bacteriologist and the way the social scientist uses the word culture. These differences seem to me to arise from differences in perspective. The social scientist considers a culture from the standpoint of a person in its midst. He thinks of it as including (I quote Mrs. McCamy) "everything material and social, with the exception of the biologically inherited equipment" of this reference person. The culture is everything that surrounds the person. The bacteriologist, on the other hand, looks at his cultures from the outside. He thinks of them as units which include all of the organisms and all of the medium involved. Furthermore, he has a rather different outlook on biological inheritance, for a bacterial generation may be over in twenty minutes. Thus in a twenty-four hour period the bacteriologist may observe as many generations as the social scientist would in fourteen centuries. Thanks to this, the bacteriologist is made aware of correlations between the potentialities of a specific culture and its past experiences, which lead him to think of biological inheritance, not as something independent of cultural conditions, but as something intimately bound up with them.

More significant than the differences between these two concepts are their similarities. Both the social scientist and the bacteriologist are concerned with the study of organisms whose behavior they know to be affected by a host of environmental factors, both material and social. This common realization, which is reflected in their employment of the word culture, is an important factor in determining the sorts of problems which they select to study, the techniques which they use, and (perhaps) the results which they obtain.

The early realization of the importance of cultural conditions in determining bacterial behavior has led to some interesting innovations in the classification of these organisms. In general, as you know, plants and animals are classified according to the appearance of individuals. Bacteria, however, must be recognized by cultural characteristics. We distinguish different species by such characteristics as the type of colony which they form on an agar medium, or their ability to ferment glucose. Whether or not a particular species has ever before existed on an agar medium or come in contact with a glucose molecule is unimportant. Obviously the classificiation of bacteria is based not on their appearance or even their behavior in their native environments, but rather on the potentialities which they may be induced to reveal in the laboratory. The sum of these potentialities defines the species. One may speculate on the extent to which this must be true in classifying any culture.

There are great differences in the sum of potentialities exhibited by different bacterial species. Some, such as H. pertussis, which causes whooping cough in man, seem to possess very limited powers of adaptation. This species has been found only in the respiratory tracts of Homo sapiens. In order to isolate it in the laboratory one must use complex organic media containing blood. On the other hand there are jacks-of-all-trades such as Cl. butyricum, an organism which can be isolated from the soil and water of at least three continents. This organism has so many potentialities that since its discovery in 1879 it has been rediscovered as something else at least twenty-two times. Once it was described as an anaerobe which could not grow in the presence of oxygen. Another time it was described as an organism capable of utilising the nitrogen of the air and thus enriching the soil. A third time it was described as a species of potential industrial importance because of the butyl alcohol and acetone which it can make from starch. Small wonder that the genius of Linneus should have classified bacteria together with Spermatozoa in the order "Chaos".

The cultural approach, as we have seen, emphasizes the importance of environment. It is therefore not surprising that the bacteriologist has devoted considerable time to the study of those environmental factors which are found to modify bacterial growth. In the time at our disposal we shall have occasion to study only a few of these factors.

Since the bacteriologist is forced to study groups rather than individuals, the question immediately arises as to whether the size of the group has any effect in determining cultural properties. In a weak moment one might be tempted to inquire as to how many bacteria constitute a group. If 1 is an individual, are 2 a group, or does it take 2000 to make a group? Questions of this nature are perennial in scientific work, but they represent language difficulties and we are gradually learning to treat them as such. The scientifically important question is not: "Do 2 or do 2000 bacteria constitute a group?" but "To what extent does a member of a pair, or of 2000 bacteria behave differently in a given situation from a single bacterium in the same situation."

One answer to such a question may be obtained with the aid of growth curves, similar to those Mrs. Jones exhibited last evening. If a flask of suitable medium is inoculated with a number of bacteria, these will eventually divide giving twice the original number, When these divide there will be four times the original number, and so forth. If we take counts at regular intervals to determine how many bacteria there are, we shall obtain an index to the rate of reproduction at any given moment. When these data are arranged plotting not the numbers of bacteria but the logarithms of the numbers of bacteria against time, we shall have our findings in a particularly useful form. On such a graph any straight line indicates that the rate of cell division is constant. (This would not have been true if the absolute number of bacteria had been used, hence we used the logarithms.) The steeper the line, the faster is the rate of division. Notice that at first the organisms reproduce relatively slowly. This stage is known as the lag phase. Then the rate of reproduction increases to a maximum at which point it becomes constant for a period known as the logarithmic or straight-line phase. As the food is exhausted or waste products accumulate, the curve is seen to reverse itself. Curves of this type are extremely useful. When environmental conditions are controlled, they may be used in comparing the growth rates of different species, or when the species is maintained constant they may be used in studying the effects of factors such as size of population, temperature of environment, previous cultural experiences, etc. They apply as well to the growth of a rat or the population of England as to the multiplication of bacteria.

The curves in Slide I show graphically that the number of bacteria introduced into a given medium may have profound effects upon the properties of the culture. E. coli - an organism found in the intestinal tract of almost all mammals has been used in these studies. When a flask of broth was inoculated with 2 cells of E. coli per cc., the organisms failed to increase in number. When the inoculum contained 20 cells per cc., growth was established but only after a long lag phase. By increasing the size of the inoculum to 200 cells per cc. the lag was appreciably shortened, and when 2000 cells per cc. were introduced, logarithmic growth was initiated almost immediately. The medium and the conditions of incubation were the same in all four flasks. It is therefore apparent that the ability of a cell of E. coli to reproduce in this broth depends in part upon the number of cells with which it is associated. By slightly modifying this experiment one can show that this is also true of other species and other media and than many other aspects of bacterial behavior beside reproduction are likewise affected by population density. This is often of tremendous practical importance. Your ability to resist infectious disease depends, in part, upon the number of organisms which may invade your tissues. Success in many industrial processes is achieved only by carefully controlling the size of the bacterial populations involved.

Before leaving Slide I, it may be noted that these curves also suggest that factors other than size of inoculum are of importance. Note the points at which the population in each flask is 200 cells per cc. The curves subsequent to these points are not identical, as would be the case if size of inoculum were the sole determining factor. In the minutes left, I shall discuss a few of these other factors that may condition bacterial growth and reproduction.

One way of inhibiting the growth of E. coli is to make the medium very alkaline, as shown in Slide II. In this case the same inoculum, 2000 cells per cc. of medium was used in each flask, but the medium in one was made alkaline. The degree of alkalinity (or the pH) in each flask is indicated by the figures beside the curves. The higher numbers indicate greater alkalinity. Study of these curves shows that E. coli is capable of making the medium less alkaline. It appears that the pH must be lowered to about 7 before logarithmic growth is initiated. If the inoculum is large enough, this is done during the lag phase. From such curves one might suspect and experiment demonstrates, that the more suitable the medium, the fewer the number of bacteria required to initiate growth. A splendid food such as milk, is therefore particularly hard to preserve since only a very few organisms are required to initiate rapid growth in it.

Slide III illustrates the effect of quite a different environmental factor, temperature. In this case the activities of the organisms do not appreciably modify the condition which is being studied. Note that not only the length of the lag but also the rate of logarithmic reproduction is affected by changing the temperature. In general, the higher the temperature the faster the rate of growth. This familiar fact is illustrated in our folk-lore by the saying that "thunderstorms sour cream". (By changing the temperature, one seems able to control that inner time which Mr. Troy discussed last fall.)

Alkalinity and temperature are but two of a tremendous number of environmental factors which have been found to affect the behavior of bacterial cultures. In general such factors are interdependent. Thus, if the temperature is optimum for growth, the organisms can withstand extremes of alkalinity or acidity, but if the temperature is unfavorable, the pH must be carefully adjusted.

The behavior of a culture may also be conditioned by the past experiences of the cells with which it is inoculated. This is illustrated by the curves in Slide IV. In this case the type of medium and the number of living organisms inoculated were the same in the two flasks but the inoculum used in one case was taken from a young culture in the logarithmic phase whereas that in the other was taken from an older culture. Similar differences may be obtained when inocula of the same age but from different media are used. There has been a great deal of debate as to the mechanism responsible for thus changing the apparent potentialities of cells. In some cases all of the cells seem to become slightly modified. Thus the cells from cultures of tubercle bacillus may contain from 2 to 50 percent fat depending upon the amount of glycerine in the medium, and an organism containing 50 percent fat differs detectably from one containing but 2 percent. In other cases the properties of a culture seem to be modified by selection. When a culture is transferred to a new medium growth, at first, is frequently slight. Only a few cells seem to be adapted to the new conditions. However, if these are able to transmit their characteristics to a significant portion of their progeny, later growth may be abundant. Here, incidentally, is another reason why size of inoculum may play a decisive role in determining the ability of an inoculum to initiate logarithmic growth. A large inoculum would be more likely to contain a few individuals with the required potentialities. The fact that strains of organisms are modified by past cultural conditions has been utilized with great success in medicine and industry. Disease germs become modified by the conditions under which they exist. This fact underlies the development of vaccines such as that used by Jenner. The smallpox virus was so changed by growing in cows that it was incapable of causing smallpox in James Phipps, but fortunately was still capable of making him immune to the disease.

We have seen that the behavior of bacterial cultures is correlated, among other things, with species, size of inoculum, environmental conditions and past experiences. In the description and classification of bacteria all of these points must be considered. Thus in describing the pathogenicity, or ability to cause disease, of Staph aureus, the bacteriologist states that "0.1 -0.5 cc of a 24-hour broth culture injected intra-venously into a young rabbit is generally fatal in 24-48 hours". The description would be considered glaringly incomplete if any one of these details were omitted, because all must be observed whenever the experiment is repeated.

We have seen that when studied as cultures, bacteria do not reveal themselves as aggregates of identical independent cells, but rather as units made up of cells which may be more or less differentiated and which are certainly inter-dependent. It is therefore not a mere coincidence that the rate of multiplication of bacteria may be expressed by a curve of the same type as that used to describe the growth of an animal such as the rat. Both curves represent the successful struggle of groups of cells placed under environmental conditions which, at least in the early stages, put a premium on mutually beneficial cell activities. An interesting question that suggests itself at this point is: Why do we speak of the individual bacterial cell as an organism when in the case of the rat we reserve that word for the aggregate of cells? One might go further and ask why we should not by the same tokens, refer to the population of England as an organism.

In these few minutes I have tried to give you some idea of how the bacteriologist proceeds to study his cultures and of the picture which this study reveals to him. If the picture seems somewhat complex, if it seems to involve rather a large number of factors which are all intricately inter-related, is it not because these factors are best thought of as attributes which can not possibly be dissociated from the thing itself? Could one conceive of a bacterial culture which lacked organisms, or one which lacked an environment, or a past history? These things are not independent entities but different aspects of 'culture'. They are arbitrarily conceived notions which we find useful aids in the processes of analysis which are essential to increasing our awareness of the world of which we are a part, Other investigations of other cultures, cultures of beans or of rats or of men will probably reveal much that will remind us of our picture of bacterial cultures. Is this because beans, rats, men and bacteria are all so similar? Or is it because similar methods of investigation have been used in the different studies? Or perhaps are 'types of subject' and 'method of investigation' also but different aspects of the same thing?

THE PHYSICIST AND MODERN CULTURE

Francis F. Coleman

The unity of modern science is emphasized by the definition of a physicist as some one who uses his senses for observing, mechanical and thermal instruments for measuring, and mathematics, especially the mathematics developed in the service of physics, for reasoning. Nothing is said about the subject matter to be investigated, and indeed there is no limitation. Already in the new science, physicists are working with living material. In fact, modern biology is often called the physics and chemistry of living processes, and the best definition of life is "A dynamic equilibrium among polyphasic states". Physics and chemistry have become different names for the same search for knowledge, names used chiefly to indicate an amicable division of labor and training in a field too large to be covered by one man or twenty men. Yet only a little over a hundred years ago there lived Thomas Young, the last scientist "who knew everything" scientific!

For the historical reason that its earliest investigations were those most suitable to the development of the scientific method, physics underlies all science. Why then is it such a strange and horrid subject to most of you? By an accident of language most of the results of physics are not associated with its name. A chemist is trained as a chemist and works as a chemist, and when he makes a remarkable new dye or identifies an unknown substance in a murder trial, the credit goes to chemistry. Similarly a geologist learns geological history, mineralogy and the physics of the earth, goes out and finds oil by physical means and we all praise geology. So also the laboratory and mathematical researches in biology, psychology and sociology are applied by men and women identified with their respective fields by their usual names.

But not so with physics. To be recognized as a physicist one must be a pure research physicist in spite of the fact that pure and applied science in any field are so bound up together as to be inseparable. For instance, a pure physicist, Hertz, discovered radio waves. Marconi applied them so profitably as to stimulate much pure research which produced vacuum tubes which made possible a billion-dollar a year industry which has spawned countless more discoveries from pure research in electronics. The applied physicist may be a radio engineer, an electrical engineer, a designer of lenses, an acoustical, refrigeration, or air conditioning engineer, a naval architect, or an aeronautical designer or only the census tables know what else. Removed from the context of its achievements in these familiar fields, physics seems mysterious, fantastic, and hopelessly difficult, quite the reverse of what it really is, in fact.

In no better plight with the layman is mathematics with its forbidding Greek and Arabic names; geometry, trigonometry, algebra, arithmetic, and the horrendous calculus, formerly known also as fluxions. Except for abstract mental exercise and some of the most recent and rigorous philosophy, mathematics is only the language in which the results of the experimental scientist are expressed. In stressing this, I do not belittle mathematics in the least. I merely wish to dispel the superstitious awe with which mathematics is often regarded, rather to the pleasure of some mathematicians, I fear.

To correlate the results of many experimenters, the theoretical scientist must master this language so well that he can think in symbols. For most of us, thought is the silent coordination of words and mental images--the "models" of the experimental physicist--but for the theoretical scientist, productive thought consists largely in the silent and unwritten coordination of mathematical symbols and processes.

Such thought processes are so powerful that some famous scientists suggest that mathematics may contain the ultimate truth. Sir James Jeans has even suggested that God is a mathematical physicist. But the inconsistent statements and nebulous language into which Jeans and Eddington and other great scientists are betrayed when they turn philosopher are horrible reminders that science is not concerned with the Absolute. The refusal of science to draw absolute conclusions from relative data, that is from data drawn from and hence relating to experiment, is to the mystic and the religious philosopher only less deplorable than the refusal to assume absolute values as basic axioms.

But a quite different blind spot in scientific vision has alarmed those interested in the direction of social change. Scientists have made no attempt to apply their rational methods to control the social effects of their discoveries. They have not even made a concerted effort to measure these effects. Nearly all are either so busy making a modest living or so engrossed in specialized research, or both, that they easily and complacently ignore the social, economic, and political dislocation resulting from the rapid increase in their ability to control natural processes.

The few who recognize the need for such measurement tend to shrink from the conflicts and pressures which they know would result from it. They realize that they have not even been free to choose their field in science or the specialized corner of it in which they work. They know that the pressures which have determined those things for them are not new. They see the historical course of science shaped by constant interference from pressure groups of all kinds, political, economic and religious. They know that fundamental research is biology and psychology has been almost non-existent until very recently because this stubborn irrational opposition has withheld the financial and moral support necessary to large-scale research.

These few socially responsible scientists recognize also the momentum which causes showily successful and apparently promising research--however unscientific the method of appraising the promise may be--to flourish at the expense of less popular fields, as the older sciences (chemistry, physics, including astronomy, and geology) have expanded at the expense of biology, psychology, sociology, and scientific economics. Especially in the newer ones, but very markedly in all these several fields of research, now closely cooperating in the use of a controlled rational method, these uncontrolled irrational influences have decisively affected the growth of knowledge.

Let us now examine a few of the more conspicuous results of research in the physical sciences. They have often been cited as outstanding among the material achievements of the human mind. I review them here not only to remind you how they affect our daily lives but also to suggest how blindly and inefficiently they are being used.

The basic requirement of the industrial revolution was power in large quantities. Factories were crowded together where coal was cheap and in individual factories many machines were crowded together to permit the efficient use of steam power from large engines. But steam engines are wasteful at best, and most wasteful when they are used to operate machines coupled directly to them. So as soon as it was understood some sixty years ago that energy could be carried from place to place as electricity with almost no waste in transit, the rapid development of electrical devices was assured. The problems of generating electrical energy from burning coal or falling water, transmitting it over long distances with only slight loss, and reconverting it into heat, light, and mechanical energy in convenient amounts have been almost completely solved by physicists in laboratories and in engineering establishments.

It is now a fact, as well as a campaign slogan, that cheap power can be brought to home and farm as well as factory. With better planning, better coordination of effort, and rather less financial gain to the few, this might have been done long since. A serious obstacle has been the primary need to protect investments in obsolete equipment still capable of yielding a profit from a small amount of power sold at a high price. Another obstacle less often mentioned is the excessive cost of electrical appliances and in particular, electric motors. A wide expansion in the use of these in agriculture would greatly increase the efficiency of long distance distribution of power. By standardizing the most useful sizes of motors and using mass production methods it is possible to bring their cost down to not more than twice that of the metal they contain. (This has already been accomplished by relatively small independent producers in filling large contracts for small motors.) The concerns which should do this for heavier motors, such as the Westinghouse and the General Electric Company, stubbornly refuse to standardize. Frequent slight changes in design in motors that have been essentially the same for years keep the price up to about ninety instead of twenty cents a pound.* This excessive cost to the consumer

* Sears, Roebuck list motors at about 35¢ per pound in sizes up to and above 5 H. P. This shows what <u>could</u> be done by General Electric, etc.

restricts the use of electrical energy even where it is available at a low rate.

Another failure to use the electrical energy made available by physics is to be charged against the eastern railroads. Only one of several lines urged by government experts to treble their electrified track mileage has had the vision and the courage to proceed. The Pennsylvania Railroad has continued an aggressive electrification program right through the depression. Other lines have said it was not practicable. Perhaps not, but their judgment seems open to question. Last May they were flooding their passengers and the general public with propaganda against the reduction in fares ordered by the Interstate Commerce Commission. Now that the fare reduction has greatly increased their earnings and they have been saved for the moment in spite of themselves from the rapid loss of their business to road transport, they are crowing about their cleverness. Electrification of railroads for long distances in areas of heavy traffic is technically practicable. The failure to attain it is wasteful of power and of the scientific effort that made it possible.

Another waste discouraging to scientists is that involved in the inefficient competition between road and rail transport. Scientists who have devised materials and processes which have made possible modern motorized transport and the highways on which it runs see only slight coordination among the various transportation agencies. The carrying of freight and passengers for long distances by truck and bus lines parallel to existent railroad lines is wasteful in the extreme. However, it has done what nothing seemed able to do, it has brought the railroads some inkling of how obsolete their equipment has become.

Aviation is often held up as a great achievement of physical science. One often hears, too, that it, at least, is a positive benefit wrought by the war to end war. The fact is that aviation is only now beginning to recover from its war time perversion of design. Its most important function is surely the safe aerial transportation of working civilians and their goods. Instead it has been developed primarily for speed and maneuverability, that is, for military and sporting purposes rather than for productive use. Even in its proper capacity of transportation, aviation has been seriously thwarted by that great frustrater of all science, economic nationalism, in that long distance transportation by air in Europe is restricted in its flight over national boundaries. In the past thirty years over five thousand million dollars have been spent on aviation. How little of that enormous sum has been spent on useful research is shown by the failure to provide sound commercial design, by the failure to provide the utmost safety in the air, and by the failure to provide adequate ground aids to navigation.

Not until after the disastrous series of crashes in recent weeks were facilities for improved radio reception in transport planes made mandatory. Even the announcement of this provision is largely a screen to cover up the lack of concentrated research which would lead to such necessities as altimeters giving at all times the true height above the ground, be it seashore or mountain top, and thoroughly dependable radio communication.

"Communications!" What amazing achievements they are; telephone, telegraph, cable, and radio; and how stultified and frustrated by many of their uses! Five years ago, I mouthed wishful platitudes predicting the early realization of true internationalism, that "era of good feeling" in which nations, (I mean peoples, not their rulers) would come together as friends and in which life in the various countries would be enriched by stimulating contact with different customs, different ways of pursuing happiness. How hollow it seems today! Tune in the world on short wave and what do you get? Reactionary conservatism from London, frenzied lies and the sickening tramp of marching feet from Nuremberg, hysterical mob enthusiasm from Rome, and claims and counterclaims from stricken Spain. In reading our daily press with its phenomenal "coverage" of the news, one of the most dependable ways of obtaining information is to discover an inveterate liar and believe the opposite of what he says! Of what worth is our vaunted annihilation of distance when we use it chiefly to spread lies and half-truths?

But let us escape from this particular frustration of science and take solace in some broadcast music. How thin and unsatisfactory it is! Hardly half the frequency range of musical sound can be transmitted due to the crowding together of stations on the band of wave lengths allotted to broadcasters. Fewer stations, each with at least twice the present frequency range, could today provide music from our receiving sets that would amaze even the expert by its fidelity. But such music is not available, so we turn to our records and find them highly enjoyable until we compare them with high-fidelity recordings of hill-and-dale or sound-on-film types. If this latter most modern photo-electrical method is aggressively developed we shall have far more satisfactory reproduction of sound than we have ever known, but will it be developed? We dare not be too confident, in view of what has happened to the other type just mentioned, which gets its name from the fact that in it the reproducing needle moves not from side to side but up and down, over hill and dale. It was highly developed in conjunction with long-playing records but is not on the market because of the investment in obsolete equipment for making and playing the ordinary lateral-cut records.

I shall forego criticism of the phonograph itself except to point out that acoustically it is severely handicapped by having to be a piece of furniture as well as, or even instead of, a musical instrument. But what about the house in which we are listening to this music? What has it gained from science? It is better than over half the houses in this most enlightened of countries in having adequate sanitary facilities, but even these are probably of archaic design. If it does happen to be airconditioned instead of just over-heated, the equipment is probably a wasteful hodge-podge, ingeniously but not scientifically arranged. As for its acoustics and sound-proofing--well, just listen in any house--on this hill or off it! In basic design, the house is untouched by science. Its shape and structure are fixed by tradition, as is its method of construction. (Perhaps one must expect this of an industry dominated by craft unionism!)

Like all others, the building industry requires for its advance improvements in materials and processes. In spite of its blind and stupid failure to support physical research many improvements are ready for its use. New building materials have been developed and new processes of construction have been perfected, but they are not being used, largely because the lack of organization of the industry and its conservatism born of ignorance have not permitted their manufacture in sufficient quantity to make them cheap. This lack of vision is strikingly illustrated by the history of the exciting new aerogels, colloid expanded glasses, which combine transparency with heat-and sound-proof properties and are lighter than cork. It is now six years since they were first produced in the laboratory, where they remain waiting for the modest support which would make them available to builders. If only they could be proven useful to the military, funds would be appropriated for their development, which would then cost from five to ten times as much as it would in an efficient laboratory.

The fate of the aerogel is similar to that of efficient white-light gaseous-discharge tubes which some day will be developed from the present neon signs which assault our eyes everywhere. A concerted attack on this problem, through research costing probably less than a mere million dollars, would solve it in a few years. But what research is being done is inadequately supported if not actively discouraged because of the investment in the hot-filament lamp industry. We are told of the millions saved annually by the improvements resulting in the present Mazda lamp but we are not reminded that the gaseous-discharge lamp is many times as efficient as the Mazda, which converts only a few hundredths of its electrical energy into light.

I have given you only a few instances of what physical science has done in contrast with what it might do. They are only glimpses of a sorry spectacle to which individual scientists react in various ways. Since scientists (even physicists!) are members of society and subject to the same pressures as their fellows, their reactions are by no means sure to be rational and scientific. In general, their views as to the place of science in society reflect those of other middle-class citizens who think that scientific research should be entirely subservient to industry and who are occasionally thrilled by its magical material effects and by the unwarranted inferences wishful writers draw from its mathematical mysteries.

Among discontented scientists, those capable of submerging their reason, and that cynical sense of humor which Lin Yutang calls "old roguery", under the crusading spirit become cranks like the erstwhile great chemist Professor Frederick Soddy. Formerly a colleague of Lord Rutherford, of atom-splitting fame, for over twenty years he has done little scientific research and has been a thorn in the flesh of economists and other predominantly well-adjusted persons. He advocates not a dictatorship of the proletariat but an oligarchy of scientists. I quote him: "Bitter and justifiably so, as many of the critics of science are, surely nothing bitterer could be said of it than this, that its abundance has but enthroned the wastrel. Nor is the solution,.......that science should look for a new master. The solution is for the public to acknowledge its real master, and, for its own safety, insist on being ruled not by the reflection of a reflection, but direct by those who are concerned with the creation of its wealth rather than of its debts. It should require that its universities and learned societies should no longer evade their responsibilities and hide under the guise of false humility as the hired servants of the world their work has made possible, but do that for which they are supported in cultured release from routine occupations, and speak the truth though the heavens fall."

Unlike Soddy and his ilk, many scientists who recognize the need for change realize that they cannot be trusted as an intellectual oligarchy. They advocate a thorough-going reform of our social order and look toward the international organization of democratic socialist countries. Some who hold this view are actuated mainly by a desire for social justice. Others, while aware of the need for social justice, state frankly that they are desperately afraid that if a change is not made they will soon lose their means of livelihood. All these advocates of socialist democracy regard "economic nationalism" as being the foe of all freedom of thought and particularly unfriendly to scientific progress. The constant change in industry and society based on the use of continually increasing knowledge cannot be tolerated by economic nationalism, which tries to freeze industry and society into wasteful economic self-sufficiency. The eviction of intellectuals from Germany andqthe paralysis of science in Italy are lively warnings to these scientists, many of whom, especially those in England, consider their plight so desperate that they must choose socialism now before fascism destroys their careers.

All but the most complacent and conservative scientists recognize the need for a rapid increase in our knowledge of man as an organism. Techniques of measurement in psychology, biology, sociology and economics must be developed rapidly, for in their development and application lies our only hope for controlling ourselves and thus controlling the powerful technology we have built in our environment. I have said that the physical sciences have been made to develop faster than the others because of obvious economic need and financial gain. Very potent also have been the influences of religious and other groups relying on absolute authority instead of rational thought in the direction of human affairs. Absolute authority and irrational loyalties to religious, political, and economic power, and even to the power of creative inspiration, have had thousands of years to make men happy and we are told that there is more misery and more anxiety today than ever before.

Let us try a new tack. Let us learn about ourselves with the tools which physics, chemistry and mathematics have put to our hand and let us make this knowledge available to everyone capable of using it. When we have done this we still shall be much as we are now but we shall constantly weigh by rational thought the effects of our irrational impulses. Only then shall we be free to build a scientifically rational society in which there will be leisure for all and poverty for none.

SCIENCE AND THE RECONSTRUCTION OF IDEAS

Margaret Patterson

My paper will deal with the first question raised in our first discussion. This question has Tecurred several times. You evidently want us to deal with it more explicitly. Let me try to state the general position which seems to be implied by your questions:

> "Is not science--with its graphs and correlations, its test tubes and instruments--an entirely different process from the processes of art, religion, and philosophy with their respective values, standards, ideals?
>
> Does not science deal with the physical and religion with the spiritual?
>
> In other words, although science is indeed a marvelous accomplishment, we need to remember that the use of our experimental scientific methods only enables us to answer questions about man's body. Human existence is still an ultimate mystery. Do our new methods really give us any way of knowing more about man's soul?"

Now of course I do not claim to be able to answer such questions. Yet I think I can point to some things that have a bearing on the way we feel about these questions and perhaps I can show you why I think these questions have become problems for some of you as well as for many other people in our culture to-day.

As I see the problem, there are two questions:

1. In emphasizing the fact that science may best be considered as a method, do we mean that it has no implications for beliefs about other human activities?

2. What, specifically, is the source and what are some of the consequences of this feeling that we ought to try to separate the more ultimate ends and processes of science from those of art and religion?

I believe that science has grown out of ordinary human activities. In the course of these activities certain common-sense distinctions were made. Science is a method of stating these distinctions much more precisely and then verifying them. Through this process we have rejected a number of distinctions and categories formerly held to be valid and significant. We speak of these rejected notions as superstitions, irrational beliefs, or mere verbalisms.

What are some of the distinctions that ordinary, normal people would use if they were thinking and talking about themselves and their world in non-technical terms? It goes without saying that these people would not debate among themselves as to whether or not they were alive. I doubt whether they would be troubled as to whether stars and trees exist. I suspect none of them would try to convince others that a plague might be good. These men would talk about food and the weather, their work and play, what their children were doing, and what their fathers had said. In other words, they would discuss happenings and events of all kinds--events that had happened to them, events they would like to have happen to them. They would discuss their own experiences and many, if not all, of the experiences of other persons.

Our talk--if it is significant and not mere verbal fireworks--has to do with natural events, which we name, recall, commemorate. Moreover we can connect some of them and thus from one event can predict other events, past and present. We make these common-sense distinctions and predictions in our speech and through our behaviors hundreds of times each day. One way of describing an insane person is to say that he is unable to achieve even a minimum of these distinctions in making his adjustments to things and persons. Because we use these categories we are apt to forget that we did not create them. Yet they are ours by virtue of our participation in the cultural heritage--all of this non-biological inheritance about which Mrs. McCamy was talking. The manner in which we as individuals learn to use them is the psychological process Mr. Newcomb described.

Our pre-historic ancestors blundered along for thousands of years, gradually evolving and testing these distinctions, passing some of them on from generation to generation. I refer to such things as distinguishing the recurrences and the differences of the seasons, or the connections between the events: planting seeds, eating bread, securing food for hungry children; or, again, such a thing as the belief that wherever one finds ashes there must have been a fire. We take such things for granted and have difficulty in realizing that they are dependable instruments which man has laboriously and painfully fashioned.

Let us take another example, before continuing, and look at the connection between the making of these "ordinary" distinctions and their elaboration and testing through scientific procedures: Our ancestors ate long before they talked about food. And it is evident that they talked about food for thousands of years before they talked about the science of nutrition. What we have now learned enables us to talk more significantly, that is, more precisely. We can name more of the foods that are apt to poison or nourish certain people under certain conditions. Fortunately, this process does not end in a loss of appetite on our part. Our knowledge of nutrition need not necessarily make us feel as though we were seasick!

Now it seems to me that the development and use of scientific methods has made a great difference in many of our beliefs. Because of our biological and anthropolgical knowledge, we tend now to think of men and their activities as natural events. Since we know that natural events have a material basis, it no longer bothers us that man can be studied according to the categories and procedures of physics and chemistry. This is not the only way we can study man; yet this physio-chemical study in no way prevents, rather it enriches, our study of man's activities according to psychological and sociological procedures. To say the same thing in another way: we are no longer shocked to hear that chemical processes in man are no different from chemical processes in the rest of nature.

We do not think of any events as more or less natural than others. All events are not put in the same class when we talk about how valuable they are. Microbes are just as natural as men, but we call some of them pests and enemies. To the degree that we kill microbes we can say that one part of nature is destroying another part of nature. There are other processes which make it possible for us to speak about man's re-creation of certain natural materials. I refer, of course, to events such as the draining of swamps, or making steel houses out of iron ore, or building a cathedral out of blocks of stone. All these are arts. Through them, man transforms and re-creates the crude materials he finds. It depends upon our perspective whether we call any given end-product of this kind good or beautiful. But in general, we might wonder whether man would re-construct these natural materials if he did not find the process and the product satisfying.

The same natural context in which these arts originated is the context which, when studied, throws much light on that particular art which we call thinking. Gestures, shouts and cries, words, conceptions, and ideas are all implicated in natural events. Originally they were responses to these events; now they are ways of describing them. Since we have abstracted certain aspects of the earlier responses, we can now deal with these as symbols. We no longer have to make an inherent mystery of language, communication, thinking--wonderful as these are. If you will take the hypothesis that these are adaptive tools, developed through the necessity of conjoint, social behaviors, I believe you will find it a suggestive way of thinking about the conditions under which we and our ancestors learned to talk and think. It seems to be a much more fruitful hypothesis than the assumption that thinking is something going on completely inside a man, a magical, under-the-skin process having no inherent connection with other conditions we can study and understand. Scientists have hardly begun to work on this problem, but the data already secured would seem to indicate that it is possible to speak much more precisely about this process, as well as about other processes formerly considered mysterious.

Not only our ideas but our values relate to this same natural scene. People have preferences. All events are not equally pleasant. We know that cyclones may destroy us, and we are not indifferent to this possibility. Man's interests and purposes frequently conflict--both in idea and in practice. A unification of values is something to be achieved.

Since our values are not private affairs, but inherently social in their origin and consequences, they are necessarily dependent upon certain economic and political arrangements. We would not be able to enjoy our artistic and intellectual activities here at Bennington College save for the fact that through the functioning of a number of economic and political institutions and customs we are provided with food, clothing, shelter, and many luxuries, and thus can devote our time to what we call "higher things".

When I speak of the natural context, it is a category which is very inclusive. It includes categories which refer to inorganic nature; it also includes social and cultural categories. This is only to repeat that man is thought of as being completely naturalized; all of man's activities are within nature.

Our new knowledge makes it impossible for us to use anthropocentric terms when describing nature. We can still do it, in poetry, of course--but we can no longer make such a point of view basic for our theory of values. When I am particularly happy, I like to imagine that the sun glows and shines for the purpose of celebrating my joy, but we can no longer really think the world was created in order that we might be here. "Friendly" and, for that matter, "hostile", does not seem to be a significant way of talking about the whole of nature. In practice, if not in philosophy, we always distinguish and appraise the natural forces separately in terms of their consequences for us.

Thus, on this basis, it is not meaningful to talk about the universe's conservation of our values. We see these words in certain books and therefore think they must mean something. It seems to me that man, the part of nature that has values, will be the part of nature to conserve them to the degree that they are conserved. I like the fugues of Bach. I feel so strongly about them that I can understand the way people feel who describe them as "eternally beautiful". I hope these fugues will be preserved --in books and in the musical activities of men. I do not expect them to be preserved in any other way. Whether we conserve and extend our values is a matter of conserving and perpetuating our culture. In our world today, a consideration of these questions quickly leads us to the realm of economics and government.

Some of you are probably thinking: "What about ideals? Do they relate to this same natural context? Do they have anything to do with the conditions which the scientist studies?" Again let us take an example: Because of certain present cultural conditions which we shall discuss before this series is over, it is quite conceivable that it might be possible for Americans to create conditions where hunger would be eradicated, where men would no more be sick with despair and hunger than with diphtheria. Many people, thinking about such a possible condition and desiring to bring it to pass, call this an ideal. Now obviously this ideal, this imagined condition, does not already exist somewhere up in the skies. It is something to be realized. Ideals which have meaning for us are describable conditions which might conceivably result from acts we might perform.

In talking about these things in ways which seem rather obvious to most of you, I have been outlining a basic metaphysical position, that of naturalism. I have been talking about man and his natural environment. I have suggested that human arts deal with nature and transform it. This position not only seems to appeal to common sense; it enables us better to understand what we do when we experiment and test, sing, or write poems. Likewise, I believe this interpretation can be significantly applied to the activities which we term "religious". There are some persons and groups working in religious education on such a basis.

But let us turn to our last question, namely: why are we still wanting to separate science and values, or science and art? Many people have difficulty with the general metaphysical position I have just sketched. This is due to the fact that we have not inherited merely the fairly consistent patterns I have described. We have inherited this naturalistic position, to be sure, but we have also inherited the Hebraic-Christian tradition. This tradition, in all its richness and diversity, has itself perpetuated many different interpretations of nature and man. Yet some of the more persistent patterns clearly imply a different approach than the one I have outlined. Different ways of thinking about values and science are involved. This results in confusion. I should like to point to some of the consequences of our failure to criticize and reconstruct some of these inherited beliefs.

The following quotation may help us see the problem. Of course this discussion is an oversimplification, but at least you will see some of the difficulties in attempting to understand science without reinterpreting these inherited beliefs. The quotation is from Prof. William Ernest Hocking, of Harvard:

> "There exists another world than this world shown us by the senses. This other-world is somehow veiled from our ordinary perceptions; and yet it is continuous with nature, and of easy access in either direction if one has the right path.
>
> "It is the residence of powers or agencies which we distinguish as divine; they always know how to get at us; we are not so clear how to get at them.
>
> "This word 'divine' indicates a superiority both in power (or reality) and in worth--the human world, which may not last forever, being regarded as derived from that other world, which is eternal, as constantly dependent upon it, and as obligated to the deference of worship and obedience.
>
> "There are ways of living which are in harmony with the divine powers, and other ways which are strictly out of harmony; and these ways can be known.
>
> "The souls of men, or some of them, pass over at death into this other world."

What are the consequences of the perpetuation of this traditional point of view? What happens when we try to use it to understand science or ethics or religion?

In the first place, we have two kinds of knowledge on our hands--the data that relate to natural events, that is, the data of science, and a kind of "knowledge" relating to a changeless world, veiled from our ordinary perceptions. We do not know any conceivable operations that men might perform which might give verifiable knowledge of this so-called "other world". The "other-world", it seems, is a verbalism, a word with a history, but with no significant meaning to-day. Our knowledge is tentative, probable; it relates to developing events. What does it mean to have knowledge of a world that does not change? How can our dynamic world, the natural universe described by the scientist, depend upon a static, changeless world? If science really related to one world and religion to another, I could understand this position, but under the circumstances I have all kinds of difficulties. Yet some such assumption seems to be at the root of the attempt to separate science and religion, or science and art.

Secondly, if we make the assumption that there can be two methods of knowing, two valid intellectual methods, we shall place scientific procedures on the same footing and basis with methods such as authoritarianism or some immediate, private, incommunicable experience. Laboring under such assumptions, we shall have to spend our time proving that scientists do not mean what they seem to mean when they interpret their data. Methods other than those of science are said to furnish the criteria. This process of "interpreting" science is exactly what many people are doing to-day. You might be interested to know that a Sunday School teacher in Alabama was the first person to suggest to me that such a process, carried on by secular as well as religious educational leaders, is one of the sources of mal-adjusted personalities.

In the third place, if we take such an approach to our ethical ideals and standards, if we place their origin and validity in some "other-world", men are relieved from the obligation of judging the concrete consequences of their acts. If we assume that our ethical standards are derived from a non-social context, it is difficult to see how such standards can be helpful in understanding and judging events in our world. This point of view seems to absolve us from the necessity of making moral decisions in terms of the only things we can affect. It removes our ideals from their natural and social setting.

I believe that these traditional beliefs in another world came about in various ways. Some of them were efforts to deal with the same behaviors with which we now deal more significantly by means of our experimental methods. Many of them were undoubtedly expressions in the form of myths and metaphors. Some of these poetical expressions were taken literally, and, in the course of time, were institutionalized and built into a metaphysics which ends by invalidating the very experiences which generated it. In rejecting this interpretation, it is not necessary to reject the fact that men do have experiences of wonder, amazement, worship. Our genuine values do not depend upon this particular interpretation. It is because I want more of these experiences, and want them more securely established and more widely shared, that a more adequate understanding of them seems to me to be imperative. I think such an approach is more apt to lead to that piety which is one of man's oldest and best values--what Santayana has called "man's reverent attachment to the sources of his being and the steadying of his life by that attachment".

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STATEMENT

by

Stefan Hirsch

I too, fail to see any actual conflict between science and art. They are merely employing two diverse methods in a perpetual attempt at interpretation of the universe. As a matter of fact, they may be thought of as complementary phenomena of cultural expression, and the apparent conflict between them is not due to inherent weaknesses of their own structures, but to peculiarities of the structure of the society in which they and we exist today. This has not always been so and it does not forever have to remain so.

In reading Mr. Jones' paper, which I did not have the good fortune to hear, I was struck by the fact that his definitions of science, with the proper word-substitutions, could be applied quite conveniently to definitions of art. Listen to this: (I quote from Mr. Jones) "Investigation by quantitative analysis is the essence of science. It is the method of discovering relationships among phenomena by inventing appropriate concepts and symbols in terms of which these relationships can be measured." I could substitute: Investigation by qualitative analysis is the essence of art. It is the method of discovering relationships among phenomena by inventing appropriate concepts and symbols in terms of which these phenomena can be gauged.

Here you have an incomplete, but by no means useless, definition of art. By art I mean, of course, all the arts and, because of their very variegated natures, all definitions will have to be applied with discretion. But this can be said. that while both art and science use abstract symbols for working materials, the scientist employs mathematical ones while the artist uses plastic, acustic and linguistic ones. The scientific method as described by Mr. Jones is a method of investigation by process of hypothesis, experiment observation (to which I should add: objective observation) and measurement. I submit that the artistic corollary to this is: a method of investigation by process of thesis or theme, subjective observation, experiment, and evaluation, which here is synonimous with formulation. That art too is a method and a faith hardly has to be mentioned. But in Mr. Jones' quotation from Thurstone I find the following sentence: "It is the faith of science that an unlimited number of phenomena can be comprehended in terms of a limited number of concepts or ideal constructs". Similarly it is the faith of art that an unlimited number of phenomena can be interpreted in terms of a limited number of concepts or ideal constructs or, as we should say, styles.

Nobody would deny that with all these similarities there is also an essential difference between science and art, and I believe that my word-substitutions already indicate its character. Science concerns itself with quantity; art does concern itself with values,--aesthetic values, moral values, religious values, historic values and so forth. This is in response to un-material, or if you prefer the un-scientific word, spiritual needs of mankind which science cannot and does not propose to satisfy. But science recognizes their existence and even studies, observes and at times measures their manifestations. The only possible conflict I can admit here is one of temperament between the unhappy scientist with no artistic strand in his make-up and the unfortunate artist with no scientific curiosity in his soul.

As I said in the beginning, the conflict exists, but in a totally different quarter: society today has not managed to integrate either science or art. The branches of science which are most apt to furnish commercial results and least apt to lead to the understanding of non-material phenomena and behaviours, are the ones which our society subsidizes most heavily. Psychology, social and political science, anthropology, even medicine, are step children if you measure their status in terms of sums of money spent for their support and development. Not only is there a lack of incentive for the traditionally entrenched, legally sanctioned vested interest to support studies whose results do not produce strictly material profits, but there must exist a definite aversion to branches of learning which might furnish dangerous and uncomfortable knowledge.

As to art I shall again quote a passage about science, this time without alteration: "Whenever it falls into the hands of a leisured class, remote from the toil of ordinary people, and is used as a badge of social superiority, or become the solace for neurotic intellectuals who want to escape into the logical symetry of complete abstraction, it ceases to be science, because it denies the very laws of its own growth..... It is pure if you like, but sterility is the natural consequence of this kind of purity." Art has certainly come dangerously near this state in its use by society, but I may add here, in order to forestall premature sentiments of "I told you so" that to the intelligent student of art not all so-called abstract art will come under the heading of the "logical symetry of complete abstraction" and that all new art is attacked by the philistine with the invective "abstract".

In the high milleniums of Egypt and China, during the great centuries of Greece, the Middle Ages and the Renaissance and surely throughout all primitive peoples the structure of society was such as to permit of an intimate and intricate relationship between the sciences and the arts and society at large. Unless we again construct a society in which all the sciences and all the arts function integrally, we are headed for chaos. To return to Medievalism seems to be a rematice Utopia. This and anything else proposed by such vested interests as reactionary educators, the banks, the bar, the church, the press and fascist philosophers, with the express purpose to maintain the profit system as the central core of society, must be viewed with suspicion even by the naive. The artist is not equipped to figure out what a coming society ought to be, and the scientist, by definition, cannot commit himself to prophecy. There is your conflict.

STATEMENT

by

Edwin Avery Park

No definition of art will be found until we cease trying to make it what it is not--one definite thing. Perhaps it is safest to recognize in art a way or ways of communicating. Like speech it is a vehicle for communicating experience. We do not demand for speech a definition such as we are asked to achieve for art. Speech is simply speech of all kinds conveying many ideas. No two people have the same thing to say or the same reasons for speaking. The similarity between art and speech is suggested by pictographs and hieroglyphics. The need for art may simply be a further manifestation of the need for communication. We do not ask what is the need for speech--we simply accept it.

Art as a language would communicate among other things ideas derived from the environment of artists which in the case of today is heavily charged with the method and discoveries of science. There is new news to be bandied about, a new experimental method to be tried out and such concepts as determinism, indeterminism, etc., to inform creations. There is the question, often encountered, of whether art used for propaganda is art, the answer to which, of course, is that it may be and it may not be, depending upon the individual artist. With artists as with scientists there will be those who prefer to remain entirely free from adherence to any motive save detached concentration on the work itself, the objectivity necessary to independence or the independence necessary to objectivity.

I wish to illustrate briefly the environmental relation obtaining today between art and science by showing how art has both abstractly and in some instances more literally communicated the new environment.

Possibly the most interesting illustration will be one reflecting the scientific method of work, one in which the artist synthesizes in his creation the result of a most painstaking analysis of the structural relations existing between all of the materials that enter into a given problem, arriving at the ultimate establishment of what might be called a configuration. His materials are, in addition to the physical paint and canvas, such considerations as space, time, gravity, light, number and the psychological and subjective factors which include the eye and the brain. The system for training artists evolved by the Bauhaus made of the studio a laboratory in which an experimental technique was applied to materials and a logical, appropriate system of relations discovered. The emotional involvements of literal subject matter were ruled out and an attitude of pure detachment sought in abstract form. Purely logical constructions of a severe and impeccable beauty were the fruit of this discipline. While this does not identify what we call art and what we call science, chiefly owing to an apparent divergence of aims, still the interrelation of the two may be seen.

Photography, in focusing attention on the problem of objective vs. subjective vision has intermingled its influences with the foregoing. Photography furnishes the most accurate and detached descriptive material to the scientist. It has recalled the artist's attention to the structure and textures of life and matter, and contributed to the movement in favor of an austere and chastened declaration of materials as themselves in vogue among present day designers.

The incorporation of scientific symbols within art expression has been called scientific mysticism, the analogy with, say, the Christian mysticism being easy to see.

Possibly the clearest and simplest demonstration of this environmental relation between, as we say, art and science, lies in the projection of Freudian symbols, as well as others, into surrealist art. Surrealist art, beyond realism, is across the border into the psychoanalytical gloom of the unconscious. With the painting of Salvatore Dali, the technical aspects are purely derivative, while subject-matter and general content account for the relation with science. Dali's technique is, if anything, early Flemish and borrows very little from experimental, analytical method, being herein the exact opposite of the Bauhaus procedure mentioned above. The same is not true, however, of all surrealist painters.

During the course of these evenings spent over Science and Culture, the question "Are art and science incompatible?" has several times been agitated. If there be any truth in what I have just pointed out it will be clear that the whole question falls to the ground since there can be no issue there. Are stone walls incompatible with rail fences or houses with hymn books? There is no competition, no interference. On the other hand a fascinating and inevitable cooperation is growing. It is always to be remembered that once upon a time, and I refer to the 15th century, there was little to distinguish an artist from a scientist. They exchanged discoveries and heaped fuel on the fire which warmed them both. Was Leonardo artist or scientist?

CONTRIBUTIONS OF THE PHYSICAL SCIENCES TO CULTURE

Richard Wistar

You have been hearing in these meetings a great deal about the conflict into which scientific advances have plunged us. This paper will deal more particularly with those advances. Dr. Osborne and Mrs. Jones showed how the population of the western world has increased recently and the complications that have arisen from that increase in numbers of people. The numbers of objects available for us, and of stimuli with which we must cope, has increased to an even greater degree. Here at College we have a terrifying assortment of radios, victrolas, newspapers, books, classes, letters, and phone calls, and the week that contains less than three evening meetings is counted a dull one. Compare our type of existence with that of an Eskimo or a lighthouse-keeper; the difference is largely one of multiplicity of objects and stimuli.

Besides the nearly overpowering effect of great numbers of things, certain ideas that have come out of scientific research have had a widespread influence on thinking, and certain materials that have been developed have made possible entirely new experiences. To illustrate this, I need only mention such theories as those of evolution, relativity, and indeterminism; and one of the most significant ideas on the horizon is thebrilliant synthesis by Korjybski of the advances in Mathematics and the Sciences which will finally release us from the throttling influence of Aristotelian logic. On the material side, the development of the art of glass making made it possible to handle gases and liquids easily and to measure them accurately. With this and the perfection of the balance in the 18th century the Physical Sciences were able to forge ahead on a quantitative basis.

The Atomic Theory was one of the first results of this new, quantitative approach. Ever since the days of the Greeks we have had the only two possible theories about matter--one, that it was continuous, and the other, that it was discontinuous. It is a mistake to speak highly of Democritus and his school for holding what we now believe to be the correct view. It was pure speculation unsupported by factual evidence. Far reaching generalizations like this must start from accurately determined facts, and to decide between the many theories which we are ingenious enough to devise to explain a situation it is necessary to check the deductions from each one by careful measurement. This method of procedure that I have just outlined is the very heart of the Scientific method and I shall repeat it--first, facts, then a theory which is a general statement that unifies and correlates the facts. Usually there are two or more theories that look equally well,yet are contradictory. We then take them one by one and figure out what more should be true if the theory is correct, and when these deductions are found to be false, the theory is wrong and needs to be patched up or discarded. If, in the testing of a theory, a great many deductions are found to be true, the theory is a pretty good one.

It was not until weights and volumes could be measured accurately that Dalton was able to formulate the modern atomic theory. A few years later Brown, a biologist, noticed that fine pollen grains dispersed in water jiggled about in a haphazard manner. When quantitative measurements were made on this phenomenon, the Brownian movement, and the results treated by mathematical analysis, it was found that if water is made up of small discrete particles then that is the way pollen grains would be expected to behave. The atomic theory pictures these molecules as being in constant motion as a result of which they bombard each other and nearby objects. This bombardment is not exactly equal on all sides but the unevenness is so slight that it shows up only in the case of a small object like a pollen grain. A deduction from the theory was thus found to check with observed fact, and we gain more confidence in our theory.

The idea that matter is composed of atoms underlies nearly all recent work in Science. In trying to synthesize some natural product we must first find out how the atoms are arranged, just as a carpenter must have a plan to go by in building a house. Frequently a substance combines undesirable with desirable properties. The job then is to associate certain properties with certain parts of the molecule and then to build up a molecule in which the parts we don't want have been eliminated. For instance, cocaine, though an excellent anesthetic, is very poisonous and habit forming. From its rather complicated structure the part was singled out which gave it its anesthetic properties. A simpler substance was then synthesized containing this desirable structure and we had novocaine, which is a satisfactory anesthetic and is far less poisonous and habit forming than cocaine. Our ideas about heat, light, sound, electricity, and many other fundamental concepts are based on the atomic theory of matter. Without it progress would be nearly impossible.

A tremendous step was taken in emancipating mankind from ignorance and superstition when the idea of a vital force back of the changes going on in living matter was overthrown. The crucial experiment was Wohler's synthesis of urea. He took ammonium cyanate, which is a typical non-living salt and by heating it obtained urea which hitherto had always been formed by some mysterious processes in the body. So long as we thought that there was a vital force responsible for what happened within us, Medicine had no hopes of becoming a Science, Psychology was impossible and many of our important industrial processes were out of the question, such as the synthesis of indigo and of alcohol from inorganic materials. That step toward the understanding of life was taken over a hundred years ago. Another crucial step in that direction was taken last year when a substance having all the properties of inert non-living material was found able to reproduce itself.

The method of identifying a substance by the color of the light it gives off when very hot has been a valuable tool for the Chemist, and when used by Astronomers to discover that everything we see in the universe is composed of the same elementary materials, it served to stimulate the imagination of every educated person. This knowledge is tremendously exciting to the imagination and compels breadth in our philosophy. Research of this type is impossible without means of making accurate measurements.

Scientific advances like these affect not only the thinking of the great leaders of Science but also the everyday lives of all of us. It was in 1874 that Gibbs developed the Phase Rule. This expresses a relationship by which one can predict the properties of mixtures from measurements on a very few different samples. It puts system and order into what would otherwise be a haphazard, hit-or-miss series of tests. As Mumford points out in Techniques and Civilization, we are now entering an age of electricity and alloys and it is by experiments directed by the Phase Rule that metallurgists have developed the thousands of alloys that underlie our present technical culture. It is surprising how very few naturally occurring substances can be used by man without changing them and mixing them to develop desirable properties.

Alloys are one essential link in the chain of developments which makes mass production possible. It is, of course, only through mass production that we can have the multiplicity of objects that I mentioned earlier. Mass production assumes mass consumption and this, in turn, depends on low prices. By way of cheapening the process of manufacturing, a tungsten steel alloy has been developed which keeps a good cutting edge at high temperatures. It can do far more work per unit time than the tool it replaced, thus cutting down capital investment. This same purpose is served in the rubber industry by accelerators. A small quantity of an accelerator cuts down the time needed for vulcanization from several hours to a few minutes. Automobiles have been made less expensive by using vanadium steel instead of high carbon steel. The new material has the strength of the old and can be cut to fit instead of ground down to the proper shape, a very expensive operation. Rapid and cheap railway transportation is made possible by alloys that have the strength of steel with one-third of its weight. This also effects a saving of our natural resources. The ultimate cost of a product is lowered by lengthening its life. To this end, alloys such as stainless steel and Monel metal have been developed to resist atmospheric corrosion, and the strong acids used in industry are handled in containers of duriron which is an alloy of iron and silicon. Aluminum alloy pistons are used in airplanes both for their lightness and their ability to conduct heat away from the cylinders rapidly.

Whether we like it or not, modern warfare is an outstanding characteristic of our present culture, and it is alloys that have made it possible. The great guns must be of a specially strong steel, the armor plate of the battleships must be as tough as possible, and the noses of the bullets must be exceedingly hard to pierce this very tough armament. All of these are made of alloys chosen after years of research and which will soon be made obsclete by the results of research going on right now.

The explosives which start the shell on its way were made by a series of processes requiring special alloys and one step in particular deserves further mention. Before the War the only source of nitrogen compounds, which are essential in explosives, was Chile. The large reserve which Germany had stored up was exhausted within two years after the blockade, yet they carried on. Where were they getting their nitrogen? They were using a method which Haber had just developed for taking nitrogen from the air. There is an inexhaustible supply of it, and the fact that ammonia could be made from nitrogen and hydrogen had been known for years. It wasn't until Haber studied the reaction carefully to find the best conditions for a good yield and then developed a reaction vessel that would stand the temperatures and pressures involved that the method became commercially practical. When this method was coupled with one for turning ammonia into nitric acid developed by another German, Ostwald, it became possible to make nitrogen compounds cheaper than it was to dig them out of the ground in Chile and transport them. One of the principal reasons for blockading has thus been removed, and nations easily isolated now have less to fear when going to war. This has had a far reaching effect all over Europe as well as in Chile.

The present tendency towards economic nationalism is being affected in two ways by Science. It is being furthered by the attempts to make more efficient use of existing raw materials and to find substitutes for those that are missing. This will result in the discovery of many new and valuable substances. On the other hand, certain natural materials and rare elements that are very restricted in their geographic distribution are becoming practically indispensable. Rubber which can be grown in only a few tropical countries, is an example of this. Though chromium, tungsten, platinum, molybdenum, and many other metals are used to only a slight extent, they are nevertheless of great importance and they are found in very few countries. The time is coming when we will no longer tolerate a huge, heavy piece of steel in a place where an alloy would be more economical of space and energy and more pleasing to the eye. The country that tries to be completely self contained can never get beyond a comparatively crude technology.

High explosives as used by the engineer play a less dramatic role than they do in warfare but they are of first order importance in our lives. They are used extensively in mining, oil well drilling, agriculture, and highway construction. The Panama Canal could not have been built without them.

Besides being essential for death, in the form of explosives, nitrogen compounds are essential for life in the form of fertilizers. Animals and plants must have nitrogen as food, yet only a few plants have mechanisms for using that which is free in the air all around them. All animals and most plants must have nitrogen fed to them in combination with something else. The Haber process, is therefore one of fundamental importance in scientific agriculture.

Replacement of rule of thumb methods of agriculture by scientific ones is becoming more and more necessary now that the population problem is such a serious one. Soil erosion is cutting down the area available for cultivation, the elements originally present in the soil have been removed to a great extent, and the population of the world, after remaining nearly stationary for centuries, has doubled itself twice in the last 200 years--all of these make it important for the farmer to grow more per acre than formerly.

Though we need no longer fear a nitrogen shortage, phosphorus, another element needed by plants may give out in the near future. All the known deposits are being worked and they are being used up rapidly. It has been discovered recently that most of the phosphorus in fertilizers is in the wrong form for use by plants, and when the proper form is found it will greatly lengthen the life of our present supply. Problems such as these--nitrogen and phosphorus shortages--were not even realized until methods of analysis became available. Now, by an analysis of the constituents of the soil and of its physical condition, the most efficient use can be made of it. In many cases soil itself may become unnecessary and we may grow some of our vegetables on trellises with their roots in tubs of water containing the proper salts in the optimum concentration. If this country continues its present course we may be spared the fate of the Chinese who were driven out of a large part of their country by soil erosion.

It is rather interesting that one of our first insecticides was originally used to poison intruders in a vineyard in Bordeaux, France. It was found that the grapes treated with this mixture of copper and arsenic salts were left alone, not only by the neighboring boys, but also by fungi and insects. A great deal of research is now being done to find effective insecticides which are not poisonous to humans.

We have seen some of the ways the Physical Sciences have influenced our thinking about life, and the world around us, and the part this branch of Science has played in the development of certain typical aspects of our culture such as mass production, rapid transportation and communication, modern warfare and modern agriculture. To some of these you have unconsciously applied the adjective "good" and to others, "bad". It is the applications of Science you call "good" or "bad", not Science itself. The scientific method is merely a tool, a method of procedure, by the use of which mankind can arrive at a greater knowledge. This knowledge is power--we must respect its ability to help us or to hurt us. If we were given our choice of knowledge or ignorance about some phase of life surely no one would choose ignorance. With this increased knowledge we have more control over our world--we can direct its changes to suit our desires. Whether we like it or not, changes will come, and if we wish to have a hand in shaping future events the scientific method is a powerful tool for our use.

Though in the past scientists have shown very little interest in the social consequences of their work, a new point of view is arising. The Rust brothers realize the unemployment that their cotton picker will bring about and are looking for a way to avoid it.

Hazelett, with his method for rolling sheets of metal directly from a bath of molten metal, is investigating the social implications of his invention before allowing it to be used to any great extent. Cottrell and his Research Associates are helping to develop ideas that give promise of lowering the price of important commodities. Because of their work the price of aluminum is due for a big fall in the near future. All these are blazing a trail, the goal of which is Science working in complete cooperation with society. The scientists will not only make discoveries but will try to figure out their social implications and will show society the way these discoveries can be put to use by society for its greatest advantage.

THE SIGNIFICANCE OF TECHNOLOGY IN CULTURE

George A. Lundberg

Preceding papers have dealt with the fascinating results of the adoption by man of a certain technique of living on the earth, namely, that technique or method which is called science. It is my dismal lot to deal with the most abhorred aspect of this subject, namely, the technique itself, especially as it applies to those aspects of life with regard to which science has as yet not been extensively applied.

The details of the technique by which man's more facile adjustments are achieved are always an unpleasant subject. Large numbers of people would like to be great violinists, but hardly anybody finds it very inspiring to draw horsehair back and forth across strings millions of times in intricate ways. Yet the latter, by a strange perversity of nature, seems to be one of the conditions of the former. Consequently many of us weaken and take up the accordion instead. Many people are sure that they would like to be great surgeons. Years of grimy training in ill-smelling laboratories are less attractive, so many would-be surgeons turn to the drugstore trade instead. Others want to be scientists until they discover that they are first expected to acquire a whole series of intricate, rigorous techniques, including a new language singularly lacking in emotional and rhetorical value. Then they take up sociology instead; or history, economics, or political science; or still better literature and philosophy. Here, thank God, is still a happy hunting ground for those who crave the intellectual life but who cannot bear to subject themselves to that particular type of technical discipline which the sciences absolutely require.

Not that these other performers work less hard or lack activity. They rush about in the social jungles, each with his own kind of chart and compass, or without either, and leave a trail too blurred for anyone to follow. The activity affords, however, much self-expression. Nor is this behavior confined to the learned fraternities. The masses of men are also greatly interested, for example, in peace, prosperity, and freedom. They are greatly bored and disgusted, as we shall see later, by a consideration of the actual techniques by which any of these ends are to be achieved, if at all. They occupy themselves instead with crusades and crusaders who propose to achieve the ends sought by the dramatic methods of knights pursuing the Holy Grail. Once in power, these enthusiasts of course have to resort to the sordid techniques that happen to work. That is, fortunately crusaders promptly violate their campaign promises and make relatively sensible adjustments instead. At this point their following usually deserts to some new crusader. At other times men keep their campaign promises and we have such results as the treaty of Versailles. The social scene is full of illustrations of this process. It is assumed that if only enough people want peace, for example, and clamor for it this will of itself achieve the end sought. The same people are frequently also bitterly opposed to all the techniques by which peace could conceivably be achieved. The sober fact is that the price of peace is higher than we are willing to pay. That price consists mainly of certain heirlooms and verbal baubles of our tribal ancestors which we value more highly than we do peace. When it comes to preventing epidemics of disease, getting across rivers and mountains and making roads smooth we take a much more practical view. We consider at once the technology involved and proceed to work it out.

It is the thesis of the present paper that the social predicaments which have been precipitated by the technological developments which my colleagues have chronicled are to be resolved only by further technology, this time in the field of social sciences. I know of no better summary of the matter than what Rosenthal recently said when the reporters asked him about his piano technique. "Technique," he said, "it iss like money. I don't like it, but I got to haf it." This paper deals with technological revolution in the social field and especially in methods of thinking about the social order. You may not like it but you got to have it.

It is clear from the papers that have gone before that every improvement in man's adjustment ability as far back as we know within historic times has been achieved not by some fortunate mutation in the human species but by some technological improvement. When we confine ourselves to that much smaller field of man's adjustment endeavor, namely science, it has again been pointed out that the means of every advance has been some technological innovation. The invention of the microscope and the telescope made it possible for us to deal with vast domains previously shrouded in impenetrable mystery. Without some of the gadgets of Mr. Coleman's laboratory physics would still be in its infancy. But not all of these technical improvements have been machines, glass or steel contrivances. Some of the most revolutionary have been verbal, linguistic inventions, i. e., ways of thinking and talking about things--e. g. new mathematical tools. Since the former type of instruments is relatively well known, I shall deal in this paper more especially with the latter type of technology.

The aspect of technology which is most familiar is that which resulted in the Industrial Revolution. More recently the same aspect has been much publicized from the standpoint of unemployment and other contemporary economic problems. Millions of words have been written on the subject during the past five years and I shall therefore pass over that phase of the matter as sufficiently elaborated.

Another aspect which has also received considerable attention is the Veblenian theory of the effect of a machine civilization upon traditional thought patterns governing other phases of life. This points out that, to be associated daily on every hand with mechanical devices, the behavior of which we have become accustomed to regard as in no way animistic but as entirely explained by well recognized mechanical laws, tends to cause us to take the same view of human behavior and social affairs. Unquestionably, the modern era of industry is the tone-giving factor in contemporary culture and this tone has in turn been in large part responsible for the trend towards materialistic, mechanistic and naturalistic interpretations in psychological and sociological sciences. In short, modern science is a habit of thought induced or accentuated by the machine technology, and these two are therefore thoroughly compatible. This mutual compatibility of the machines of an industrial age with the thought pattern and methods of science has also been extensively explicated, and so I shall elaborate upon it here.

There remains a third aspect of the effect of technology upon culture which is less frequently mentioned, although it is the most important aspect of the subject. This is the effect of developments in the technique of communication upon the validity of virtually all of the most traditional, time-honored, and hitherto reliable techniques of social adjustment. While the effect of improved means of communication is given due recognition in connection with the expansion of trade and industry, and in connection with certain labor problems, far more fundamental repercussion upon the problem of social organization and social adjustments in general have received inadequate attention. The further fact that the remedy of the situation is itself a technological problem of a type largely neglected at present makes this the logical aspect of technology for the present paper to discuss.

With the expansion of the means of communication the great masses of men were exposed for the first time to a removed environment, of men and things, to which it became necessary for them to adjust. Before this time nearly all the necessary adjustments to other people were of a face-to-face nature. That is, human relations were overwhelmingly primary group relations. Now, the means and instruments of adjustment in primary groups are principally unassisted sight, hearing, and the other elementary sense mechanisms. To these man added a fairly satisfactory system of oral speech, full of animistic and superstitious words standing for the powers, the entities and the processes that were supposed to exist at the time these words were invented. Also, primary group conditions called for attention to one thing at a time, or at most, only a few individuals or things at a time. Simple group and number concepts and ways of manipulating them were developed to meet these needs. From all these ideologies, likewise adapted to local relations, were developed.

With this rather adequate equipment for life in a primary group man suddenly finds himself thrust by new means of communication into an environment including the whole planet. He is now required, if he is to behave intelligently, to take into consideration people and things he has never seen; ways of behavior, institutions, and customs which are strange and revolting to him; worst of all, he is expected to respond to vast collectivities and combinations of things in this removed environment. For all this he has only the crude tools of his local neighborhood. Yet if he and his neighbors do not appraise this removed environment correctly, the results are likely to be in the long run as disastrous to him as if he fails to appraise correctly where are the turns in the road, the ditches, and the stone walls, in his local community. He is in the position of a mariner without chart or compass, a bacteriologist without a microscope, or a physician without his instruments.

A majority of the peoples of the earth today, including their leaders, find themselves virtually in the position of the dinosaurs suddenly caught in an environment for which they are unequipped. We behold today, a world struggling desperately with primary group adjustment techniques in a secondary group environment. Technological developments of one kind brought us into this predicament. Technological development of another sort is the only hope of getting out.

It remains to sketch briefly the type of technological development which this situation calls for. All of the technological achievements of man in every field can, it seems to me, be classified in four broad categories:

(1) There are those techniques which operate as an extension of intensification of our senses, thus greatly extending our response capacities. Here we have such instruments as microscopes, telescopes, galvonometers, X-rays, etc.

(2) There are the techniques of symbolizing our responses. Here the whole evolution of language symbols tells the story. From crude picture writing to phonetic symbolization, from Roman to Arabic numerals, etc.--these represent technological advances quite as important as any which Mr. Coleman and Mr. Wistar have recounted.

(3) Closely related with improved techniques of symbolizing observations are the improvements in the rules and techniques of manipulating these symbols. Here belong the various systems of logic, the story of the substitution of Galilean for Aristotelian logic in the physical sciences, the successive inventions of Lobatchewsky and Riemann in geometry and the innovations of Einstein and others in mathematics. If all of this seems a little vague and unimportant, try to keep your bank account straight with Roman numerals. Or try them the next time you have occasion to do a simple problem in multiplication or division.

(4) Finally, there are the techniques of overtly combining materials--steel, wire, and glass, or water and gas and air, or anything else, into the concrete machines which will behave as the symbols we have manipulated on paper indicate that they should behave. This is the conspicuous and perhaps the only meaning of technology to the ordinary man. It is the radio, the airplane and the television apparatus. Behind them all lies endless manipulations of symbols on paper and checking of these manipulations in laboratories. Whether or not these manipulations on paper help at all in the final adjustment depends, of course, entirely upon whether the symbols correspond accurately to the things and the materials with which we have to build, and whether the rules by which we manipulate the symbols are compatible with the rules which

nature has laid down for the operation of nervous systems, muscles, steel beams, or any other materials. All of these may be adaptable but there are limits beyond which breakdown occurs. Many of you can doubtless put musical symbols on paper which, whatever else can be said about them, simply cannot be played on any existing instrument or by any human hands, voice, or lips. What you architects may actually be doing in the way of building names on paper I leave to your own answer, but it is quite clear what you might do. Let us look now at what social architects are doing in this way.

In passing it should be noted that it must not be assumed that the order in which I have enumerated these types of technology necessarily represent an historical sequence. All of them develop together and constantly interact on each other. Microscopes extend the reach of our senses, but first we developed glass. What we are able to see with microscopes may again enable us to develop more powerful microscopes. With more powerful microscopes we need new symbols to represent the new things we see and new logic i.e., new mathematics with which to describe how these new things behave; and so on in an inextricable complexity.

Consider now the state of social technology from the standpoint of all of these techniques taken together. (1) What are our techniques for seeing far and deep into our social environment? What devices for extending and intensifying the power of our senses in making social observations have we developed?

With a few crude exceptions to be mentioned later, we are in this respect practically where we were two thousand years ago. The masses of men still rely upon crystal-gazers, fortune tellers, and the pronouncements of ancient philosophers (the more ancient the better) for light upon the nature and state of that social order beyond the reach of our unaided eye, but which bears down upon our lives with increasing obviousness. Others, who have been to college, scoff at such techniques and decide that, since they can't see into the next county or the next state, where things are alleged to be causing trouble at home, the obvious thing to do is to take the car and go and see; and possibly even clear up the difficulty. Or if you really want to get at the remote seat of the trouble take a boat trip to Europe. As a fellow-traveler said to me some years ago: "I have been reading a great deal about Russia these last years and find nothing but a lot of contradictions, so I decided to come over and see for myself." He spent four days in Russia and was entirely satisfied that things were quite as bad as he had feared. From his reports, and from those of others like him, chiefly newspaper men, most of the literate public decides what is what. Indeed, what alternative have we? Still others, even more learned, deduce what the situation is from Aristotle's cycle of democracy, aristocracy, oligarchy, monarchy, or some equally inevitable sequence.

There remains a negligibly small number, frequently regarded as a sort of lunatic fringe, who have conceived the idea that even in the social field the fallibility of man's unaided senses may be guarded against and largely corrected by rigid rules of observation and reporting with the aid of various instruments in the form of schedules, scales, and tests. This group further holds that large numbers of carefully defined observations made over periods of time enable us to determine with accuracy the main trends of events. They find further that if such bodies of data are subjected to certain kinds of treatment and manipulation they provide a basis for actual prediction of what presently occurs. This group finds it necessary to work quietly and slowly, however, lest the public suspect that their obscure conjurings may occasionally be allowed to influence public policy, in which case there is a great outcry against brain trusts. Their resources, numbers, and influence are, however, too limited to demand much attention just yet.

But the masses of common men, when they are compelled to make major adjustments to their removed environment, rely on what they pridefully call simple common sense. The adjectives are well chosen. By common sense they mean the rules of conduct which they have in their personal experience found to work in their primary group adjustments. Statesmen (by which I merely mean men charged with the management of public affairs) rely on the same technique. For one thing most of them do not themselves possess any more refined method. If they did they could not afford to use it for they could never explain their seemingly strange behavior to their constituents. So the statesman and his constituent both adopt, for public affairs, the techniques they have found to work in horse trading or other neighborhood adjustments. There were men at the so-called peace conference in Paris who knew that the provisions of the treaty were impossible and absurd and that it must result in precisely what it has resulted in; but the technique by which they had to prove this to be so was, and is, a foreign language to the overwhelming majority of both statesmen and their constituents. The symbols and the logic by which such sequences have to be proved go beyond primary group language mechanisms.

Take a single recent example in regard to the payment of war debts. Economists are unanimous on the proposition that the only way in which the debtor nations could pay their debts, if at all, was by sending goods over here. To enable them to do so tariff walls would have to be removed or lowered. This can easily be demonstrated by the use of the economist's symbols and logic. Without going into details it may be said that these symbols differ from those of common sense chiefly in that (1) they represent large numbers instead of a few individual cases, and (2) they take into consideration interrelationships of an intricacy which goes far beyond the direct life experience of any individual. Unfamiliarity, both on the part of their constituents, with this technology is exactly what prevents intelligent adjustment in such a case. Of course, I take here the most charitable view of the situation in assuming that the recommendation of social scientists are tabled chiefly because statesmen and public have little faith in them. You have heard a great deal about how industry frequently buys up and kills valuable inventions because the inventions would, if exploited, disturb vested interests and profits in the present methods. This process is, of course, even more common in the social field.

But to return to the illustration. When confronted with the findings and the recommendations of the economists on this subject, what did conscientious citizens and their congressmen do? They referred the economist's analysis to their primary group experience and found it preposterous. "Do you mean to tell me," they would say, "that if I lend money or sell a team of horses to my neighbor, John Smith, I cannot reasonably expect him to repay me unless he can do so with potatoes, butter, or wood?" (Note that the illustrations for purposes like this are usually drawn from the local agricultural economy from which we have just recently emerged.) It is unnecessary to complete the analysis because the audience laughs in derision at the very question. They have all had something to do with deals like that. None of them has had anything to do with the kinds of deals the economist talks about. But the statesman goes on with his analysis to the proper climax. "If John Smith does not pay in cash he is a crook and I'll put the police on him. If he and his ilk resist the militia will soon bring them to terms. Isn't that what militias are for in a civilized and orderly country?" That is exactly what militias and armies are for in societies which have not yet become familiar with a symbolic technology through which the necessary adjustments can be worked out, or in which the population does not understand such a solution when it is worked out.

In the absence of this more refined technique, the technique of force and its nearest relative, fraud, is of course inevitable and necessary. It relieves temporarily some of the tensions. So do other convulsions, earthquakes, fevers, etc. If you can't collect from John Smith, it relieves you considerably to denounce him as a crook and a scoundrel, a moral pervert, a religious heretic, and a wife-beater. If you can bring physical violence to bear upon him and preferably destroy or cripple him permanently, so much the better. In addition to the energy outlet it affords, it satisfies deep-seated emotional patterns of decency and justice which we still have with us fresh from the jungle.

But it is unnecessary to draw upon hypothetical John Smiths for an illustration of the phenomenon. Nearly the entire content of all the books, magazines, and newspaper columns purporting to analyze the European situation is concerned with personalities. Nearly all of it is immaterial, irrelevant, and absurd. We resort to personalities in attempting to analyze social questions because, as I have said, it is the technique with which we are familiar in primary group adjustments and the only one we know. Indeed, the time was when we also used personality concepts and logic to explain the events of chemistry and physics. Lightning struck trees from malice and Death with a capital "D" mowed men down with a scythe just as Hitler baits the Jews and Stalin the Kulaks.

This type of description was abandoned in the physical sciences when other and more useful techniques of dealing with the phenomena were developed. These techniques do not spring full-blown from anybody's brow, unfortunately, but have to be developed by long and undramatic labor by many persons over long periods of time. This is the proper task of social scientists. But it is not likely to be achieved as long as this fraternity preoccupies itself almost entirely with more or less enlightened commentaries on current events, chiefly to assess the praise or the blame and to point out the solution in dogmatic pronouncements whether of Jesus, Aristotle, or Marx. Again there is no objection to anyone devoting himself to any of these evangelical enterprises provided he does not confuse himself or his followers that his conclusions are dictated by any canons of science. The techniques and the knowledge that constitute science are obviously as useful for the exploitation and the destruction of the proletariat as for his liberation. When so-called social scientists therefore get the idea that social science, in contra-distinction to all other science, is also privileged to dictate the ends for which the knowledge is to be used, they merely mix up with their science, such as it is, something which has absolutely nothing to do with it.

A principal reason for this confusion among social scientists is the nature of the terminology with which they try to carry on. The immediate data of all sciences are symbols of some sort representing human responses to whatever it is in the outside world or in ourselves that causes us to respond at all. To the extent that these symbols adequately represent the situations to which we have to adjust, we can behave in a way that is called intelligent as contrasted with mere squirming or trial-and-error groping.

Except for the possibility of working out on paper and later in the laboratory the formulas for high explosives, the tensile strength of steel, etc., most of the engineering adjustments on which we pride ourselves so much would be accompanied by wide-spread catastrophes. This paper work has lagged in the social sciences because we have cultivated instead the notion that it has been done, once and for all, by one or more of the aforementioned smart men, and that all we need to do is to continue to play with their words without ever bringing them to empirical definition and test. It is admitted that the phenomena of the social world are constantly changing, that they consist of an infinitely fine gradation of characteristics, constantly interacting with each other. Yet the terminology with which we attempt to deal with them employs concepts emphasizing absoluteness instead of relativity and probability, stability instead of change, discrete instead of continuous variables, dichotomous categories instead of dispersions. Practically everybody is obsessed with a set of social categories which he strongly feels are eternal. Things are either true or false, right or wrong, just or unjust, good or bad.

To abandon all these for vague new concepts representing probabilities, averages, dispersions, rates of change, etc., is too much for the masses of men at present. So they hold fast to the notions of their primitive ancestors about matters social and feel their feet are on the Rock of Ages. And so they are--on ages extremely remote. Since he does not bother to define any of his words in terms of the concrete operations or behavior for which they are supposed to stand, everyone may read his own meaning into them. The conflicts that ensue even while still on the verbal level are in all essential respects like war. The victory is to the loudest voice, the largest vocabulary, and the greatest physical endurance. The defeated party also remains unconvinced. There is not a single statement about man or society which can legitimately be made except in terms of an average, a dispersion and a probable error. Nearly all statements that are made and acted upon are in terms of some chance individual case which happened to become conspicuous.

To climax this confusion, and indeed fundamental to it, there is the still generally accepted notion that man in contradistinction to all other phenomena in the universe is a free or a supernaturally guided agent; to whom the logic of natural science does not apply. If you choose to make this postulate, you can build upon it an entirely self-sufficient logical system just as easily as upon the opposite postulates upon which science proceeds. It does not follow that each is equally workable in the concrete adjustments that free us. What I am pointing out is that these two systems will not mesh, and if you try to live by both you can do so only by developing a fundamentally schizophrenic personality. That is precisely what, perhaps, the bulk of the population of the western world especially has done. Their behavior in matters social may be recognized as definitely pathological. I am not speaking figuratively but literally. When an individual insists with sufficient vigor upon making mutually exclusive and contradictory adjustments, we call him insane and incarcerate him, provided the majority of us do not suffer from the same malady, in which case we call it normal and incarcerate the diagnostician instead. Yet such contradictory adjustment is precisely what we are attempting in such an illustration as I have cited about the tariff and the war debts, and in scores of other illustrations that could be mentioned. It is true that whole nations are not sent to insane asylums. But it is also true that they run amuck every so often and engage in what even those who do not agree with my analysis admit is obviously violently insane behavior. To a generation which possesses no technology for explaining social events other than personality explanations, it is, of course, necessary to blame it on some Kaiser or Hitler, just as our ancestors blamed measles on the devil.

The main point is that we are caught with one foot and a major part of our lives in an impersonal machine culture to which we adjust according to the assumptions and rules of physical science. The other foot and another major part of our lives we try to maintain in a vitalistic, animistic, primary group culture to which we adjust according to metaphysical assumptions and doctrines of a bygone age. Individual nervous lacerations and social cataclysms are the result. Theoretically the conflict can be resolved by going over entirely either to the one or the other or compromising the two. Actually there is not the remotest prospect that society will go back to a primary group existence, that industry will go back to handicraftsmanship, and that science will go back to medieval metaphysics. The prospects are overwhelmingly the other way. You may deplore this, but you can hardly deny it.

It may seem that this conflict is overdrawn and that the situation I have described is exaggerated. Most of you may not be conscious of any such tension at all, and neither do you observe it in your friends. If so, we may use this as the concluding example of the point I have been making regarding the tendency to generalize for the world on the basis of primary group observations. I have not said, and I do not say, that all people need become seriously embarrassed by the conflict of the two major culture patterns I have described. Some of you can simply flee from it, or you can insulate yourself against it. The principal insulating material is not likely to be taken from its present possessors for a considerable time yet. Obviously there is no need for you personally to acquire any of the techniques of thinking I have said would be necessary to solve the conflict I have described, if instead you can hire others trained in those techniques to make all your adjustments in those fields for you. All you would need is some ability to pick a competent technician. Also, the Great Society has numerous alcoves, crevices, and sheltered nooks in which considerable numbers of you may spend a lifetime relatively unaffected by the winds that blow. If the world and this new way of thinking about it is too much for you, there is still the historic remedy of the convent; or the universities and the colleges where you may still play elaborate word games that have nothing whatever to do with the social events in the world at large. If you find some of those games rather satisfactory, you might remember that many a ship that navigates so boldly in a snug harbor is tragically inadequate for the high seas.

Nor does anything have to be done about the situation immediately, even by the masses of less fortunate men. They can simply continue to suffer. This capacity of men to suffer and to endure the evils which they have is usually underestimated by the more optimistic heralds of the new day. In the meantime the upheavals and struggles which the daily paper chronicles are themselves adjustments that relieve, however temporarily, the tensions that I have described. I mention these reservations merely to emphasize that the correctness of my diagnosis is not to be refuted merely by the primary group technique of citing your own case and those of your friends to whom it may not apply. I have been talking about the main social currents to be observed in the world today, not about the private lives of privileged individuals and groups.

My main suggestion has been that the major tensions in the world today can be eased only by developing and employing in social adjustments the same type of techniques which has made man master of a lot of physical situations which have beset him for a million years. These techniques in turn rest upon a type of knowledge which can itself be accumulated only by this technique known as science. That body of knowledge, and the social engineering techniques which it would make possible, remain for the most part to be developed. To the extent that such knowledge exists today and is not put into operation, a new political regime more hospitable to science and scientific social engineering might help, but they could at best be of only trivial importance or contrasted with the development of that body of knowledge upon which the success of any regime is so completely conditioned. In the meantime, the very shape of regimes to come will be largely determined by the evolution of the social sciences. It is unnecessary here to take up the question as to whether this state of affairs will be better or worse in any absolute sense than conditions of men in the past or in the future. On this point which usually arises to befog the main issue, I can do no better than to close with a paragraph from Veblen:

> "One may approve or one may deprecate the fact that this opaque, materialistic interpretation of things pervades modern thinking. That is a question of taste, about which there is no disputing. The prevalence of this matter of fact inquiry is a feature of modern culture, and the attitude which critics take toward this phenomenon, is chiefly significant as indicating how far their own habit of mind coincides with the enlightened common sense of civilized mankind. It shows to what degree they are abreast of the advance of culture. Those in whom the savage predilection or the barbarian tradition is stronger than their habituation to civilized life will find that this dominant factor of modern life is perverse, if not calamitous; those whose habits of thought have been fully shaped by the machine process and scientific inquiry are likely to find it good. The modern western culture, with its core of matter-of-fact knowledge, may be better or worse than some other culture scheme, such as the classic Greek, the mediaeval Christian, the Hindu, or the pueblo Indian. Seen in certain lights, tested by certain standards, it is doubtless better; by other standards, worse. But the fact remains that the current cultural scheme in its maturest growth, is of that complexion; its characteristic force lies in this matter-of-fact insight. Its highest discipline and its maturest aspirations are these."

(Thorstein Veblén, "The Place of Science in Modern Civilization." pp29, 30)

Mr. Wallace Fowlie made a statement [illegible] the relation of science and culture to the point of view of the Church.

STATEMENT

by

Irving Fineman

Reflection upon Mr. Fowlie's admirable statement of a religious point of view suggests that in all this remarkable revelation of science which we have had there has been an oversimplification of its relation to the culture of which it is a part. This simplification has doubtless been due mainly to the limitations of time within which the enormous complex of science is here being displayed. But it would be a grave mistake to leave the possible impression that we are viewing a melodrama in which science is the hard-pressed virtuous hero struggling for his life in the toils of a gang of villains: tradition, religion, superstition, politics, and so on. The drama of science and culture, to use that metaphor, is realistic, hence more complex; it is more like the somewhat difficult relationship of offspring to the parents who bore and nurtured it, to whose life it is still intimately attached, and from whom it has nevertheless diverged.

It should be emphasized that folk-lore and superstition, the early expressions of accumulated human experience and observation, have been the forebears of our science. We have been told here how smallpox vaccination was begun; and it is no insignificant fact in this connection that before scientists set to work on that achievement common men had already observed that anyone who had had the cowpox resisted the smallpox. We have laughed here at the penchant of primitive peoples to use various animal organs for cures: but we quite gravely take extract of liver or or pituitary glands when our own doctors prescribe them. And is it not remarkable that the ancient anonymous author of Genesis should have chosen, of all imaginable sequences, in his story of the creation, just that sequence of animal life---first, fish, then fowl, beast and man--which our science of evolution has approved. But the point need not be labored; we need only bear in mind that our present scientific method is the result of no miracle but something which grew quite naturally out of man's ceaseless impulse and need to know his cosmos; and it appears that in religion, from the very beginning, man found a suitable repository for those aspects of his cosmos of which he was aware or had hopes but no objective knowledge. That repository still contains quite securely, and will doubtless continue to contain, for some time, such things as the First Cause and "life after death".

There was a time when religion included practically all of man's preoccupations. But with the aid of his increasing lights, of which science has been one of the most powerful, though certainly not the sole source, man has apprehended an ever-expanding sphere of knowledge. It is obvious that there can be, as Mr. Fowlie has said, no real separation, no discontinuity between the known world and the unknown; one is simply the revealed extension of the other. It is equally obvious that as man increases the sphere of his knowledge the area of his contact with the infinite unknown increases at an accelerated rate. But by that circumstance scientific man appears as yet undaunted, for his lights seem to increase fast enough to serve in maintaining the present high rate of his penetration into the unknown. Now no scientist can logically take exception to Mr. Fowlie's lucid vision of the function of religion as he stated it, or to the ideal church which has a veritable existence in his mind and heart, as well as in the minds and hearts of men like Pasteur and countless others. But we also know of more pragmatic churches, which may for example suppress a Galileo, which may countenance death dealing war but discountenance contraception, and which may maintain with assumed authority that that part of the unknown described as the future life is of greater importance to man than his life on this earth, an attitude decidedly discouraging to the spread of the scientific spirit.

With such churches the scientist of good will must now see himself at odds, no matter how greatly science itself may be indebted to them historically, just as he must see himself at odds with laissez-faire democracy, as Mr. Coleman pointed out, to which science has been so enormously indebted in the past century. The scientist must see himself at odds with a dogmatic church as with a business-for-profit economy when they obstruct his efforts to push back the boundaries of outer darkness and his efforts to create within those expanding limits a more nearly perfect, a more godlike life.

We are told that long ago when our world was yet young God saw men embarking on this quest (the symbol in that old story as a towerman said "Let us build us a tower whose top may reach to heaven"). Then God--so the story goes--became fearful and said "Now nothing will be withholden from them which they purpose to do. Let us go down and confound their language." I refer, of course, to the Tower of Babel. Since then man has found only in the scientific method a unifying mode of communication and the most hopeful means of redeeming himself from that age-old confusion. How successful he will ultimately be seems now to depend on the extent to which the scientific spirit really permeates his culture--to what extent that spirit will inform in the future the culture by which it was informed in the past.

STATEMENT

by

Francis Fergusson

For a layman who has been listening to this stimulating and able symposium, the important question, which I wish to raise again, is that of the nature and limits of the faith in science professed as I understand it by the panel as a whole.

Mr. Jones defines the scientific method as investigation by hypothesis, experiment, observation and measurement; and adds that quantitative analysis is the essence of science.

He defines the faith of the scientist, in the words of Thurston, as the faith that an unlimited number of phenomena can be comprehended in his concepts or ideal constructs.

If we are to reconcile the definition of method with the statement of faith, apparently we must specify that the concepts under which the scientist is to comprehend all phenomena must be mathematical, or concepts of things which may be measured.

Toward the end of his paper Mr. Jones seems to identify science with rationality, and to define the faith of the scientist, therefore, in another way. The discursive reason is used in many fields, including theology and the arts, which the scientist is unlikely to claim as his domain.

It is therefore a question whether we are being offered a faith in a method, which we are to believe in so far as it works, and because it works; or in the metaphysical assumptions which underlie the method of quantitative analysis; or, finally, in reason itself.

I think there is a fourth belief which is implicit in some of the papers we have heard: a faith in what the scientific method will accomplish. So far as I know this faith has never been very strictly defined, but its essence seems to be that all the problems of humanity, whether of knowledge, conduct, or belief, will eventually be solved by the scientific method. For those who accept this faith, the history of science to emancipate itself from dogma, prejudice, superstition and the opposition of various types of vested interest. Traditional ethics and religion would be thought of as surviving into the present enlightened age only because we are not yet enlightened enough, or quite healthy enough to do without them. And the arts also, cookery, the drama, music, would be regarded as fancies permitted to our ignorance but without relation to what really exists, and unnecessary to the "well-adjusted" individual or society.

Now the scientist is in a special relation to his method: it gives him something to do with his life, and the technological results of science assure him daily that he or his kind are of <u>some</u> significance. It is perhaps natural that he should not ask, even when discussing science and culture, whether his faith is in the redemptive function of science, or in the mechanical nature of the universe, or in reason.

But the arts do not use the scientific method in their proper work, and this method seems to be incapable of assigning them a place or meaning in culture as a whole.

Science offers us no values, yet we make judgements of value every moment of our lives. Must we wait for science to assign them, or can we seek elsewhere? Obviously we do seek elsewhere; but unless the relation between science and our religious and ethical traditions is the simple one of reason struggling to be free from prejudice, this relation has not been treated even by implication.

Politics, the art of medicine, ethics, religion, the fine arts are names we have for cultural activities outside science, though they may <u>use</u> science. What is needed is a philosophy of the relationships of these disciplines, which will recognize the reality we accord them in practice. One way to start would be to assign limits to the faith in science, which each of us accepts at present with a different set of mental reservations.

STATEMENT

by

William Troy

I should like to make a few remarks in the interests of something I care very much about, something in which I admit that I have a professional stake but which I believe to be of the deepest importance to all of us. I am referring to the Word, to what Thomas Mann in a recent letter has called "the purifying and sanctifying Word". Of course I am capitalizing "Word" so that you will make no mistake that I am using it in the fullest symbolical sense--in the sense, for example, in which it is used in the Christian New Testament: "And the Word was made flesh."

But if I am using it in a symbolical sense it is not the sense in which recent social science would have us believe we are accustomed to use words as symbols. They would have us believe that words are always made to stand for what they call behavior-patterns. They go on to explain that these implicit behavior-patterns involve a <u>causal</u> sequence of action. "The meaning of a pen is the processes and acts which have culminated in it, as well as the consequences, acts, etc., which follow in connection with it." Thus, every word is ultimately traceable to some previous chain of actions, of which it is the telescoped expression, and it is used only to initiate a present chain of actions. Its origin and function are both utilitarian. Words are reducible to the chatterings of apes in a jungle who warn each other that something that has happened in the past is about to happen again: namely, that a scientist from the Natural History Museum is about to trap them with a steel net. In this sense, the social scientist refers to words as symbols of behavior-patterns.

I cannot take the time to enumerate the objections that can be raised to such a description of adult human language. I will merely point out two things: first, that whatever the origin of words may have been, some words at least have so altered their meanings in the course of their history as to stand for quite different things. It is true that many words now used in an abstract context are traceable to concrete actions in the past: the word <u>sarcasm</u> originally meant in Greek "a tearing of the flesh", and undoubtedly corresponds to some early tribal feast. But what of a word like <u>solemn</u>, which in Chaucer's time meant merry or festive? Here a radical change, an exact reversal, has occurred which can only be understood as having taken place within the history of the abstract usage of the word. What I am saying is that, through the momentous accident of human consciousness, an <u>absolute</u> break takes place between words as simple adjustments to situations and words as attitudes.

The fallacy of trying to understand human thought in this way is of course what is known to logic as the "genetic fallacy": the effort to understand any human phenomenon solely by a study of its origin. (I may add that Mr. Newcomb leans toward this fallacy in his description of consciousness. He has told us some of the things that affect and condition consciousness, but not what it itself is.) I believe that a natural history of words might be written; but it would involve nothing less than an account of the whole culture in which they are found; and this would involve more combined insight and learning than is likely to be found in any one man. If you inquire why the social scientist has hit upon this way of explaining human thought, I can only respond by pointing out that he is himself conditioned to dealing with words in the way that he deals with everything else, as measurable quantities (actions) in relation (behavior situations). Quantitative thinking is the occupational distortion of the social scientist. The second objection that I would make is that individual words taken in and by themselves have only a relative significance, if any significance at all. It is only when they exist in some context, when we can perceive their interrelationships with each other, that any single word takes on definition. So the social scientist might just as well refer to clauses, sentences, and paragraphs as analogues to behavior; and such an inquiry, involving an extension of scope to the whole of human communication, would lead to madness and despair.

But I began by invoking not words, but the Word; and it is time that I attempted what is actually impossible--the endowment of this abstract symbol with a little concrete meaning. By the Word I mean that imaginative projection of the whole of human experience through the concrete medium of literature and art. You will note that I use the sort of words which the social scientist abhors; but then we are in a college auditorium, not a jungle. You will note also that I extend the meaning of the Word to include all developed forms of artistic communication.

Now every word in my forbidding definition is important and difficult, but perhaps the most important and the most difficult is "imaginative". I wish that I could offer a satisfactory definition of imagination. But too many minds have foundered in the effort--Leonardo and Coleridge, to mention the most noteworthy. The reason is that the imagination corresponds to a physics and a chemistry for which the formulae are not yet available. I am perfectly aware that this sounds mystical; but I must point out that mysticism, through its crude associations with "misty" and "mysterious", is a word that we frequently use to describe what we do not understand. I will therefore limit myself to making three large statements about imagination. The first is that it is a fusing power. It is a process by which all of a man's experience, spiritual and intellectual as well as sensory, are submitted to a pressure within himself which results in something whole and complete. You will note that I say all of his experiences; and this enables us to dispose of two points that have caused much trouble in this discussion. Man's experience today includes his use of, and his various responses to, scientific technology; and these would necessarily be involved in any contemporary act of the imagination. His experience also includes the history of both religion and science; and if it is impossible for some of us to accept the older religious authority it is because we cannot reconcile the revelations of the one with the discoveries of the other in our experience. (But I must add that there will have to be a carry-over of certain fundamental religious values and assumptions in any real synthesis that we make today.)

So much for the way that scientific knowledge is related to art; and so much for the possibility of reconciling orthodox religious experience with a fully conscious contemporary awareness. This would be the proper place also to take up the question of how we know or perceive, which I shall not take up except to say that whereas science is concerned only with certain aspects of its object, those that can be weighed, measured, etc., art attempts to give us the object in its entirety. How it does this is not through a simple projection of the artist's feeling in the object, as some scientific writers insinuate, but through an interpenetration of the object in all its material substance with the whole personality of the artist. I object, therefore, to the statement that poets never "see" the stars that they write about. Fine poets give us stars with greater exactitude than they are represented for us in textbooks of astronomy. And with this insistence that art gives us the whole object, the whole experience, and the whole man I close the first part of my statement.

My second statement about the imagination is that it involves both feeling and intelligence. Scientific intelligence and artistic intelligence are not two kinds of intelligence; but two directions of the intelligence. And I will not conceal from you my belief that since the most important area of understanding for man is man himself, the direction of intelligence involved in creation is in the long run more important to man than the intelligence involved in science. This is not to deny science any of its legitimate value; it is merely to give it a place in the scale of human values. As to the direct relations between these two directions of the intelligence, I will add that an increased activity of the one is not necessarily detrimental to the activity of the other. It is the tragedy of the European Renaissance that the two did become mutually hostile; and we are today paying the consequences of their separation in the schitzophrenic condition of society that Mr. Lundberg has described.

The third and last statement has to do with that power without which the fusion of feeling and intelligence could not take place at all, without which men and their works would be indistinguishable from the nature of which they are a part--I refer, of course, to what used to be called the moral will. This is the most horrendous concept of all: a veritable murex thrown up in the lucid waters of the laboratory. But everyone in this room knows exactly what I mean. It is all very well to say that we do things because that is the way we do them and that if we do them in this way that is because we like to do them in this way. This is a circular theory of value which is no theory at all. It is what I am tempted to designate as the Doctrine of Silly Pragmatism. And it leads to nothing--except chaos. Having been an extremely popular doctrine in this country for the last forty years, it has led to what we read in the morning newspapers.

What I suggest is that man's values, the basis of his choices, are themselves the products of his imagination. On the foundations of his experience as a man he has learned that certain values rather than others are necessary to his continued existence as a man. These lessons have been not only of a physical nature, they are of a metaphysical nature as well. In the highest acts of his imagination these values are continually being rediscovered; because at those moments he is concerned not with doing or with acting but with understanding and contemplating life, more particularly his own life as a human being--his condition humaine, in the phrase of the great tragic artist who recently addressed us from this platform. In other words, values are created through the imagination, and at the instant of their creation they give unity and meaning not only to the work of art but to man himself.

Now in the few seconds left, I will not take time to point out that at the moment art, imagination, human feeling and intelligence, and therefore man himself, are at a discount. We live in the time of contempt for these things.

What then may be proposed? What value may we establish as the highest of all available human values? I propose that to which all the great religions and philosophies, all man's triumphs in art and literature and science, attest--the value of man's own imaginative perception of his dignity and importance. This is humanism; but it is not the humanism of the later Renaissance, which was corrupted by the false division of man's reason and his feelings, in which science played an unfortunate role. Science alone cannot restore the equilibrium. Nor is it the humanism of the romantics, which I should describe as the feelings taking their revenge on the arrogant reason. For I hasten to add that I do not think any value can be made generally operative until it has been taken up and absorbed into a whole system of ideas. I therefore propose that the immediate task of philosophy is to construct such a system of reformed humanism, that it is the task of political government to give us a world in which such a reassertion of man's dignity will again be possible, and the task of economics to make concrete and practical this possibility.

THE CONTROL OF SOCIAL CHANGE

James L. McCamy

The process called social change is, more precisely, cultural change. Change occurs in the material world and we have new tools and new ways of manipulating our physical environment. Change occurs too in our non-material culture, or in the whole fabric of our intellectual, spiritual, moral, legal, or ceremonial practices by which we live with each other. Because of the intricate interplay of cause and effect, it is never possible simply to detect a particular single cause of any particular phase of change, but one general assumption shared by most students of the subject is that change in the material environment is fundamental to change in the non-material environment. This assumption is over-simplification because the material and non-material actually inter-act, but the assumption is valid as a useful way of talking about social change. Without some assumption for purpose of discourse, we would reach the impasse of the futile and familiar question of whether the chicken causes the egg or the egg causes the chicken.

As an illustration of the assumption, you are familiar with the wide non-material results of the material change in the invention of the gasoline motor, which placed in the hands of individuals the high-speed transportation previously available only through the collective operation of railroads. The social effects of this individual speed of mobility include a declining sense of allegiance to the family site because the activities of children are no longer so centered in the home, a declining sense of parochialism because people now trade and take their pleasures in places that were formerly too far away, the elimination of the isolation of rural dwellers, and increasing familiarity among individuals with power machines. Many changes in the social aspects of college life during the past twenty years could be assigned to the automobile. Now it is only accurate to say again that attributing social change to any one factor, such as the automobile, is over-simplification. The automobile is part of a large body of change in the material culture, but it is perhaps predominantly responsible for these changes in the social culture and as such has served its present purpose of illustrating the theory that material change is basic to non-material change.

There are some other accepted theories which are useful in talking about social change. The first is that change in culture is cumulative. An invention is never the result alone of one man's brilliant insight but the latest point in a long procession of contributing inventions, and the man who is labelled the inventor is merely the one who takes the latest step in applying the precedents to a new use. Another theory is that the process of change is accelerative with increased accumulation. A third theory, now generally accepted, is that the social adjustment to change in the material environment does not follow immediately but comes only after a lag. Since the lag may cover a good part of a single lifetime, the individual often never sees the final social results of material changes which occur in his time. Society as a continuing entity, unconcerned with mortality, is always in the process of adjustment, always facing dilemmas due to material changes having upset the adjustment in some phase while the new adjustment has not yet been established.

Within the vocabulary of these theories--of the material basis for social change, of cumulative change, of accelerative change, and of chronic lag--the problems of the control of change can be considered. I want to consider three aspects of the subject: one, the people who are most important in any proposal for controlling change; two, the inability at the present time to control change over a long period; and three, the role that is possible and in fact is now being filled by the people most important in change.

We have seen in previous evenings how science is, like other factors, a part of the social situation and a force within it, a result and a cause at one time. It has been intimately involved, on the side of cause, in invention which leads to technological change. In the non-material realm it has reflected the newer stages of material culture in providing an objective way of looking at our world and our relation to it. Of further significance, the whole body of technological invention and the consequent introduction of the scientific method into the non-material realm have produced a larger role for the persons who have acquired skill in working with the results of invention and in thinking objectively. These persons may be called by a number of names. It matters little what name is used so long as we understand the same thing. I call them technicians because they are the result of technology and its demand for the use of techniques, but the word here is much broader than in its usual meaning. The members of all the various professions which attend the material and some of the non-material affairs of the world are included: the engineers, architects, doctors, students, designers, and all others who have examined their world thoughtfully and objectively and who have brought into our consciousness the nature of this world. The term refers as well to technicians of future generations as to those of our day. The role of such skilled persons has always been important, of course, but the increasing acceleration of material change and the greater difficulty of learning anything about the world save by a careful study of many small aspects make the possession of skill and knowledge from observation more important than in the past. The possibilities for controlling social change rest, in short, in the realm of the technician.

But the technician in this present moment of history is deterred in any attempt to control change by very real handicaps. One is the inability to predict far enough into the future with the knowledge possible at this time. The social planner has only the stock of accumulated experience from the past with which to make predictions. Mr. Lundberg has deplored this paucity of social information and has hoped for better controls when the social sciences grow up. New changes by invention in the future may re-direct social change in a way that cannot be foreseen. Always the situation is dynamic rather than static and events not yet observed may upset the most careful plan made within the present framework. There are also limits imposed by the natural equipment available for use. Geographical barriers, such as mountains and water, are bigger than man's powers in spite of the spectacular conquests on a few scattered fronts. Plans must conform to Nature in the main for any hope of even temporary success. The planner is restricted too by social factors accumulated in the past and, due to culture lag, still prevalent at the time the technician is choosing a course. The inherited system of finance--capitalism, associated with private property, in most of the world means, for example, that many feasible plans for using our resources are simply too expensive for the community to bear without a drastic and difficult reallocation of our purposes of expenditure. Vested interests oppose recommended change; groups bring pressure with skill in propaganda (i. e., by using technological equipment to combat the change demanded by the growth of technology); classes arise from the heritage of conflict; and the advocate of change must weigh his support before he can move. A final handicap, and perhaps most important, is that the technician is himself a result of the forces he is working with and has only the experience of mankind up to his moment as a guide. He is a person as well as a technician. He can call on no external philosopher to explain the past in terms of the future; he can find no outside governor to command the ordered plan.

These handicaps of our day--and remember I am talking here always of our particular moment in history--can be illustrated briefly by the American efforts to direct change in agriculture. When the technicians of fifty years ago saw a nation of individual land-owning farmers, they decided that the most desirable future would come from making each farm more productive with less effort. A great educational machine was established by Government to promote scientific farming.

While scientific farming was being established, technological invention was providing new implements for the farm. Mass production in industry and in farming grew as a result of the newer technology. The attendant concentration of the control of wealth in the corporate form of enterprise became general. These factors made possible the profitable large-scale farming which inevitably replaced the small farmer in the competition of private ownership. Scientific farming had paved the way for large-scale farming. The destination which had been sought for agriculture by those earlier technicians was lost in the subsequent forces that are still working to destroy the individual land-owning farmer.

Before considering the effective role of the technician, another point should be mentioned. Along with the technological developments which are producing present change has gone the social condition of increasing collectivism, as shown by the prevalence of collective business enterprise in the corporation and by the striking growth of the functions and scope of government. Single individuals are unable to cope with their environment; such practices as mass production are not one-man enterprises. The task of living together and keeping apace of our material world is a community job, and this means that more and more the technicians are becoming the servants of the community. They may serve the community, incidentally, whether they are paid by government or by a semi-public, so-called "private" corporation, though, as I shall show in a moment, the number of technicians hired by government is increasing rapidly and the type of public service conducted outside of government seems to be declining. The job of the public servants in government is one of superadministration, of being able to see ahead as far as anyone can to the social consequences of material change. The job requires, in short, the application of administrative statesmanship, based upon knowledge and skill, in contrast to the romantic politics which most people assume to be the whole of present methods of government. Administrative statesmanship implies both deciding on a course from all the available facts and then bringing pressure to see that the course is adopted by the public or its representatives. The technician, in other words, must use propaganda for change in much the same way that vested interests use it against change. The whole of public administration, one historian has said, is the most important task facing civilization. Upon its successful fulfillment depends the future of man in his modern world.

We may now ask the third question: Since the technician is the all-important person in any effort to control social change and since he is at this time unable to control change in any certainty, what is the possible service to be expected from the technician? This means, it seems to me, examining the extent to which the agents of society can relieve the tensions resulting from past change, rather than being preoccupied with the possibilities of directing change over a long period towards any particular destination. The technician is the person who is going to do most toward helping us out of some of the disturbing maladjustments between social and material culture as they have already arisen. To do this he does not have to be able to order the unseen future.

The technician is now doing this job as effectively as he can with the knowledge and skills available. Furthermore, real hope lies in the fact that the system of technology now current demands that he must occupy the key position in social engineering. Certainly his effectiveness could be demonstrated no better than by removing him from the public service for a time and watching the resulting chaos. Imagine a modern city without chemists in the water purification plant, airline transportation without accurate weather reporting, use of the radio without a policing of wave-lengths, or common everyday motoring without constant analysis of and provision for traffic flow, and you can see the importance of technicians in the public service.

Even the desirable administrative statesmanship is being applied on so wide a scale that I might argue that, after the major decisions of policy are reached by the course of yielding to primary group pressures, the majority of important laws adopted at the Federal level in America to carry out the proposed policy are now made with reference to everything that can be known about the subjects. This is surprising, perhaps, because we are still in the cultural lag of thinking romantically about politics as a game of war without bullets, and we watch the plays in the game rather than thinking of that greater but less spectacular technical job which is done by skilled public servants throughout the year and which is reflected in most important legislation by the contributions of the technicians to the details of law. If you think the game of getting elected is the beginning and end of the legislator's job, I suggest that you consider some of the decisions he has to make in the course of a congressional session. If, further, you think the legislator can make those decisions without being told the facts by a person who has mastered them, I suggest that you, being a layman like the legislator, try to write unaided a bill to provide housing for 600,000 families, a bill to create social insurance for 40,000,000 workers, a tax bill, or a crop insurance bill that will work. Try to realize and decide upon all the necessary details that would go into this typical legislation. You would soon call on the experts.

The days when oratory that was full of wind and erudite words displaying ideas with a classical connation could be convincing in legislative halls has almost passed out of existence. The modern legislator listens with respect to his colleagues only when they are talking in terms of real situations rather than in abstractions, and there is, in fact, some justification for the contempt in which so-called pure theorists are held in American capitols. The legislator must have evidence because he is compelled today to adopt measures that a hundred years ago would have been considered fantastic and impossible of administration. They would be fantastic today if the administrators did not have more accumulated experience than their predecessors in the executive branch of a hundred years ago had. Even the present-day administrators still lack sufficient social knowledge to avoid all mistakes, and great improvements are to be sought.

Probably the whole American public today knows that the uniformed cop walking his beat in the same way he walked it in 1850 is not the important man in modern police protection. The significant work is done by scientists in laboratories. Not so much light has been given some of the other and quite similar developments in the characteristics of government personnel. In 1896 there were 3,629 professional and scientific positions in the Federal civil service. In 1931 there were 35,304. Both figures are for the civil forces alone, excluding the highly technological armed services. The figure of 35,304 in 1931 included, for example, roughly 850 economists and political scientists, 2,000 agricultural and biological scientists, 2,500 physical scientists, 2,700 scientific assistants, 1,500 educational experts, 23 anthropologists, 167 dentists, 2,000 medical officers, 1,300 veterinarians, 7,000 engineers, 2,500 lawyers, 1,200 librarians, 450 social workers, 8,000 medical and hospital workers such as nurses, and so on through other classifications. Remember that these figures are for 1931 when the post-war period of normalcy in the scope of government was at its peak and before the New Deal expanded greatly the Federal personnel, especially in the fields of economics and social work. The new figures are not available for the extent of technical personnel this year in comparison to 1931.

The staffs of state and local governments have increased in similar fashion. The depression brought enormous expansion by state and local governments in the social sciences, particularly in social work.

The extent of the technical services can also be grasped by considering the functions of modern government and their growth. While great numbers of clerical workers carry on the routine record-keeping, the technical worker is the keystone in all the following functions: research and practice in public health, detection and prevention of crime, the provision of safety and recreation, the administration of poor relief, making and executing plans for land and water use, research and teaching in agriculture, planning and executing social insurance, public housing, rural and urban resettlement, banking (the largest bank in the world is the Reconstruction Finance Corporation), research and reporting in foreign affairs, analyzing endless statistics on population, wages, costs of living, and domestic trade, the regulation of transportation, stock marketing, and power rates, the building of public works, operating and inventing in the economic enterprises of government, the conduct of public education, highway and street construction and control, planning and directing warfare, and in the emerging function of analyzing human needs when no effective market demand exists to express them (as in the designing of low-cost furniture or in defining a minimum standard of decency in housing).

Even this list of functions is not exhaustive. The dispensing of justice may in a few more decades join the other governmental functions by taking more cognizance of facts than of immutable legal principles. Already most of the cases heard in those important administrative courts, such as the Interstate Commerce Commission, the Securities and Exchange Commission, or the Federal Communications Commission, are decided upon facts presented by expert accountants and engineers. The work of the lawyer is fast becoming more that of understanding factual reports than in knowing only the legal precedents in an issue.

If, finally, you want to know what the Federal bureaucracy is really like, I suggest that instead of stopping with campaign oratory, you go to the annual reports of the Civil Service Commission and see the variety of positions filled by examination. The 1936 list starts with accountants and auditors and goes down through the alphabet, including nearly every conceivable technical job known to the language. Appointments made in actuarial work, agronomy, aircraft manufacture, animal husbandry, architecture, bacteriology, biology, chemistry, ornithology, conservation, cytology, dentistry, dietetics, economics (which was divided into agricultural, financial, industrial, social, and tax economics), electrochemistry, engineering (including aeronautical, agricultural, architectural, chemical, civil, construction, electrical, heating and ventilating, highway, hydraulic, hydro-electric, marine, mechanical, mining, radio, sanitary, soil, structural, telegraph, and telephone engineering), entomology, ethnology, fingerprint classification, fish-culture, forestry, genetics (three to study cotton and one to study tobacco breeding were added in 1936), geology, geophysics, public health, historical research, horticulture, libraries, lithography, medicine, metallurgy, meterology, micro-analysis, morphology, mycology, nematology, nursing, parisitology, pathology, pharmacology, photography, physics, physiology, physio-therapy, plant physiology, poultry husbandry, protozoology, psychology, social work, statistics, surgery, teaching, typography. The civil service appointments in these jobs in 1936 totalled 4,617 technicians and assistants. These were new appointments to the already existing positions in the permanent service. The large numbers of temporary and non-civil service appointments since 1933 are not included in the figure.

The social technicians, as they are now operating, are already the very keystone of our present orderly life. The man in the street relies on them every minute of every day for his safety and for his hope of increasing control over his environment. The persons who observe, record, report, guide, and invent by applying the scientific method are our protection against disease, against that always impending insect and animal world with which we are in constant conflict, against the forces of physical power which would destroy many of us if they got loose on a wide scale; and against the destructiveness of natural elements of wind and rain and wave.

The technicians can do this work with greater success, as the hopeful Mr. Lundberg pointed out, when the social sciences have reformed to provide as accurate social information as the laboratory scientist can give about his world. It is hopeful to believe that the social technician of the future may even be able to predict the short-term consequences of any choice of action. This might allow choosing an agricultural policy, to revert to the earlier example, that would avoid over, say a fifty-year term, the unwanted consequences which we can see in retrospect having come from the earlier choice of policy.

It is hopeful to me, at least, to believe that the future politics--that is, the processes of public policy-making and administration--will be a politics of prevention rather than cure and that public administrators will be able to advise the community in terms of exact social knowledge. Each year sees a greater trend toward such expertness in government. Such a preventive course in public practices would be analogous to the preventive role of medicine which has come from the application of the scientific method and the development of technology in the study of bodily disease.

But again we are thinking of a dynamic situation. No matter how perfect the information the future social technician will have at his service, he will not be able to choose an ultimate destination for society and guide society to that end. He will be able to tell society what will be the results at the moment, and perhaps for a short future, of taking any of the available courses presented by the material culture. But the step ahead is always only one step which leads into a new situation with a new problem to face. The technician will always be facing immediate dilemmas and, in terms of world history, a short future sight because the nature of the process of social change simply does not allow any condition to remain unchanged for long.

The technician can help us catch up to our material culture. He is steadily improving in his mastery of information about the major conflicts now existing in our culture. The encouraging thing is that most of our most burdensome social evils are due to our failure as yet to make an adjustment to our material developments, which are useful for good as well as ill. The solution of most of these problems does not call for long prediction into the future but merely for applying a rational method to social affairs. These problems are being solved as well as possible with the present tools by a growing body of technicians hired by the public. What will it matter if each step into the future is a step into a new dilemma so long as we can meet our new dilemmas with more experience and with more accurate records of that experience? Since change is cumulative and accelerative, the piling up of information means more and faster adjustments in the future than we know today.

TRENDS OF SOCIAL CHANGE

Thomas Brockway

Man has always dreamed about an age of the past or future which possessed qualities or values his own society lacked or possessed in limited degree. In that dream world, man was pictured as invariably successful in the hunt, or as having no work to do, or as surrounded by beautiful women or by disputatious old men or by harp-playing angels, or by rugged individuals, or, to take an English example, by illiterate warriors, each of whom had one vote.

When this society was projected backward into the past and called a golden age, some men not otherwise engaged were enabled to contemplate past perfection and close their ears to the vulgar clamors of their own times. Petrarcho of the 14th century was enamored of Greek manuscripts which he could not read, both because he had read in Latin that ancient Greece was an age of perfection, and because he despised the Italian townboys who bawled his sonnets beneath the windows of their lovers.

Dreaming of a golden age of the past was so exclusive and vicarious an experience that it must be considered one of the greatest of human achievements when some one of our distant ancestors first thought of projecting the golden age out into the future. From that moment man could escape the ills of his own existence, not by mournfully assaying a golden age which was dead beyond the powers of literary resuscitation, but by joyfully anticipating a future life which anyone could and would soon experience, either by dying in the odor of sanctity, or, more democratically, by just dying.

Whether man has looked forward or back for the realization of his dearest values, the inferences are first that his own times starved him, or mutilated him, or pained him, or tempted him, or bored him, or ran railroads across his deerpark, or forced him to pay income taxes or to say heil; and second that although incantation and prayer might momentarily soften the contingent blows of domesticated gods, society was fundamentally changeless, or if it changed, the new was certain to be worse than the old, and in any case man could do nothing about it but bear it with or without the grin.

As to the first of these inferences, we are at one with the man of the past in being more or less dissatisfied with our own world--some today because they are not comfortable--others because they have a dark premonition their comfort won't last. But the second inference has been vigorously denied during the past three centuries. Men have stated with great dogmatism that society is not static, that the direction of social change is upward and onward forever, and that man's mastery of the universe is or will be whatever he wants it to be.

This doctrine of progress is so deeply rooted in our western culture, and particularly so basic among American preconceptions, that we are amazed to discover that the great thinkers and myth-makers of the past preferred a doctrine of cycles with degeneration occurring at the moment. The Hindus asserted quantitatively that this cycle lasted 16,000 years, during which things went from bad to worse. Plato wrote that God created a perfect world, kept it straight for 36,000 years, but then relaxing his vigilance, permitted it to approach an absolute of chaos and rottenness, for another 36,000 years, when, in the nick of time, he would intervene and start the cycle anew.

Following the fall of the Roman Empire, western Europe abandoned the Greek theory of cycles, but embodied the ancient suspicion of human nature in the doctrine of man's fundamental depravity, and added the promise of salvation to the deserving, but did not postulate any amelioration of man's lot on earth. "The conceptions which were entertained of the working of divine providence," wrote Professor Bury, "the belief that the world, surprised like a sleeping household by a thief in the night, might at any moment come to a sudden end, had the same effect as the Greek theories of the nature of change, and of recurring cycles." That is to say, the medieval, like the ancient world, did not believe in progress.

The doctrine of progress arose in the western world during the 17th and 18th centuries as a product of many minds responding to similar influences among which were the study of past societies and the advance of science. Perhaps the first to formulate the doctrine of progress as it applied to knowledge was Fontenelle of the 17th century who lived in a period of transition from the intellectual domination of the ancient classics to the domination of modern science, a period which is now drawing to a close. In his writing Fontenelle boldly compared the age of Louis XIV with the golden age of Pericles in support of the thesis that knowledge is cumulative, that the mistakes of the past need not be repeated, that posterity would surpass the age of Louis XIV through improvements in science and the accumulation of human experience, and that there appeared to be no end to the process.

In the following century, the Age of Reason, when as Carl Becker once said, man denatured god and deified nature, the idea of progress became a faith of dynamic power. The wise men were then convinced that under the benign guidance of reason, human nature, being plastic, could be moulded into perfect form through human effort. Man then believed he could add a foot to his own stature by taking thought, as Becker writes, but in the nineteenth century he believed a cubit would be added to his stature whether he took thought or not. The well-fed Victorians in fact made of progress an immutable law of nature, equally applicable to fish, fowl, beast and Englishmen, an idea strongly charged with optimism and complacency. Herbert Spencer wrote of this best of all possible worlds: "Always towards perfection is the mighty movement--towards a complete development and a more unmixed good . . . Even in evils the student learns to recognize only a struggling beneficence."

These cheering dicta were very satisfying to the prospering British middle class of the last century, although the material conditions from which they sprang were being attacked before the sunset of Victorianism. While Spencer was writing, Karl Marx was asserting that every society contains within itself the germs of its own destruction, chilled beef from Chicago was completing the ruin of English agriculture, labor was organizing, and other nations, with great effrontery were raising tariff walls, and beginning to spin cotton and build battleships. If these facts led the discerning in England to doubt the perdurance of progress, the War and its aftermath fundamentally challenged the doctrine throughout the Western World. Worshippers at the shrine of progress had some difficulty in describing the four years of organized murder as "a struggling beneficence", and it may be said that the myth that progress was an inexorable and automatic law was one of the War's first casualties.

Since the War, some have followed Spengler in reverting to the theory of cycles of change with degeneration the motif and pessimism the tune; some have returned to the Church; and more have cautiously accepted the 18th century theory that human progress was not inevitable, but only possible of realization through human effort.

I have said this much about what men at various times have thought the direction of social change to be because their interpretations have played a significant role in retarding or advancing change in their own societies, and because what I can say on the subject can be said briefly. The scientists behind me would say nothing at all, since there is neither the data nor the techniques of measurement to determine whether on some score or other, social organisms have moved in circles, parabolas, spirals, or zigzags, or have followed straight lines downward or upward and onward. I am not a scientist but I share with my scientific colleagues the grave defect of being unable to say whether or not man is on earth for an ulterior purpose toward whose fulfillment he has moved, or even whether he has been getting better through the ages. Historians from time to time have dated themselves by reflecting pleasantly that man has progressed from the pre-literate to the illiterate to the literate; that the Greek superman had slaves, the medieval bishops serfs, but that we are all freemen: that man-made ethics are today somewhat more humane than they were in pre-literate ages. But less sanguine historians have asserted with equal dogmatism that man is not what he used to be, whether from the point of view of virility, intellect, morals, or feeling.

Between the scientists and the historians I shall risk the remark that the direction of social change has been in general from the simple to the complex, as Aristotle used to say, and that this process has gone apace with man's increasing mastery over his material environment through the application of the dull concept of cause and effect, and the cumulative nature of the results. If we go back far enough in the distant past of conjecture, life must have been, as Hobbes and Mrs. Jones have remarked, nasty, brutish and short. But by his discovery of the appropriate cause for the desired or unexpected effect, he was enabled to produce his own food, and as a farmer he ceased to be a parasite. This remarkable revolution in human status was at length followed by the grouping of men in communities based on industry and commerce, and there we find them at the beginning of written records. Fifty centuries ago, there were on the Nile and in Mesapotamia "ordered government, urban life, writing and conscious art." (Childe: New Light on the Most Ancient East).

This change from purely agricultural to moderately urban life was accompanied by increasing diversity of activity within the social organism as a result of differentiation of function of the individual. We may select as illustration what some will think an excessively crude aspect of our society: the production of goods for human use. The first townsman doubtless remained a dirt farmer, but he was also, let us say, a metal-worker, and then in the course of time, he specialized in a single metal, and then in one article made in that metal, and by the 5th century B.C. in Greece, candelabra were made by four sets of skilled workers living in different cities who specialized in pedestals, stems, branches and lamps. This trend in production though by no means uniform from then to now, has been particularly noticeable in the past four centuries. Today the hypothetical metal-worker of pre-literate society has millions of occupational progeny standing at conveyor belts, looms, power presses, doing less and less faster and faster, to the end of producing cheaper gadgets, cheaper automobiles, cheaper bombing-planes, cheaper novels and cheaper reproductions of the old masters. Man the producer appears now as an adjunct of the machine, but the social result is that man the consumer is overwhelmed with machine-made goods, and his standard living, though low in relation to what it might be is higher than it has been at any period in history for which we have relevant data for measurement.

I have chosen the illustration of production not because it is evidence that there is progress, but because of the dynamic role technology and economics have played in social change through the centuries. During the past five hundred years, changes in the mode of producing goods have made a major contribution to the transformation of the economic, political and social organization of western civilization, and leave stocked the museums of lost causes with those ethical, legal, economic and social concepts of feudalism that obstructed the insurgent rise of capitalist economy; and there can be no doubt that technological and economic change is today, and will continue to be, a major, some have said an irresistible force, in the future transformation of our culture, including our ethic, and any ethic that refuses to take this fact into account will make no significant contribution to social change.

I have said that the direction of social change has been from the simple to the complex, and have suggested the cumulative nature of the process by which our physical environment has been exploited by man. I shall risk the further statement that the trend of social change has been toward collectivism. In the perspective of history, the economic individualism of the last century appears to have been a momentary and insignificant aberration of time and space, whose roots were being destroyed at the moment of its most Victorian bloom. The trend of change from the Heidelberg man to Hitler has been toward a collectivism on a larger and more complex scale. In our own day more intense collectivism is dictated by the obvious fact that our exceedingly complex capitalist economy has produced problems it cannot solve, populations it cannot employ, goods it cannot sell, and wars it cannot win. Every Great Power has recognized the problem, and every answer to it is collectivist in nature: social planning, fascism, communism. It is obvious furthermore that collectivism on a national basis is but a narrowly parochial solution of problems which are today of world scope. If there is progress during the remainder of the century, writes Charles A. Beard, it will be mass progress measurable in averages and susceptible to graphic representation.

The trend of cultural change in our times may strike some as inimical to culture as that word is used on the street and in the ivory tower. But may I point out first that the material goods I have abstracted from human history include not only wheelbarrows, oxcarts, covered wagons, automobiles, and flying machines but also ornaments, temples, sculpture, crucifixes, violins, paintings, and books and there is no reason to expect that man in a society even more collectivist than our own will be able, or will care, to live on bread alone, although here, as in the case of ethics, no art that shrinks from the implications of our social trends will significantly influence those trends.

Finally, for those who are alarmed at present currents, it should be added that society is a strange welter of jarring, spasmodically enmeshed, groaning and changing systems: economic, political, aesthetic, philosophical, educational, religious; and though these systems are interdependent in varying degrees, each system has its own inner compulsions and inertia and pride of place which give it a tempo of change unlike that of any other system. Consequently if the trend toward collectivism be painful, it may be considered proof that we are no worse off than our ancient ancestors that any individual not otherwise employed still has the golden age of the past to comtemplate or a life hereafter to anticipate. In one or other of these jarring systems, there are spiritual havens and intellectual speakeasies where the individual can find like-minded souls with whom he can joyfully contemplate release from the worldly frame, or find a sorrowing satisfaction in recalling the golden age before the flood, the barbarian invasions, the reformation, the world war, the new deal, or the Science and Culture Series.

STATEMENT

by

C. Harold Gray

It was the profound emotional reaction produced in this audience by two of the statements made at the last two meetings that has prompted me to prolong discussion of certain topics. The murmurs of approval following those statements differed quite distinctly from the applause given to the equally admirable papers by members of the panel. One cause of the peculiar reaction was literature, indeed the word.

Literature too is a method, a tool -- and it probably would be admitted by the scientists here that it has been a powerful tool in the building, guiding, or transformation of successive cultures. They have been showing us the place which science holds in our culture; they have brought out an array of achievements which no one could or would deny; they have made clear the uses and have hinted at some of the limitations of the tools they use.

In almost every paper there has been an explicit statement -- and members of the panel have in answers to questions repeatedly stated -- that neither individual nor social action has its ends determined for it by science, but that both individual and social action for certain ends can in definite ways be aided by the scientific method. So far no sensible person, it seems to me, can disagree, and yet the emotional perorations in many of the papers were quite justified by the too widespread failure of men and women to be sensible.

The reasons for this failure to be sensible are also good problems for scientists to work upon. Some of those reasons were made almost visible and audible by our reactions to the stimuli from that other human tool, literature, in those moving statements on what is to me incomprehensibly called "the other side".

The use of all tools in this world is for the double purpose of action and understanding. Living is behavior, and behavior is the object of contemplation and investigation, by scientist, philosopher, and artist. Understanding, in infinite varying degrees of complexity and certainty, underlies all action. The presentation of the value of the understanding which science can give and has given in great abundance has been made here with a cogency and on the whole an impartiality which have not stimulated, at least in me, any fundamental denial or resistance. The understanding science gives promotes our adjustment to the world of things and men every hour. Even the adoption of the method, though the conclusions drawn may at times fail, aids in that adjustment.

In dealing with disease, for example, what we most need is not certainty that the methods we use will unfailingly bring a cure. We suspect, in fact, that a hundred years from now those methods may seem as obsolete and fantastic as the bleeding and cupping which men a hundred years ago relied upon. What we really need is the emotional satisfaction that in the illness of some one we love we have used all the available means at our disposal. The method of science, which unquestionably in our present culture will be pushed to its farthest limits, also deserves that emphasis.

But in the meantime there are other methods of contemplation and investigation. Some of these, as Mrs. Jones said in one quiet sentence which should have put a stop to much of the discussion that has followed, -- some of these are not only valid as methods for arriving at understanding but are even more comprehensive than that of science. What she will not agree with, I presume, is the assumption that underlies whatever antagonism has grown up in this audience: namely, that the adoption of one method excludes the use of the other. When she spoke of the artist as one who takes in more aspects of an object than science does, she did not mean that it was thereby better or worse than science. But it seemed to me that she did admit at once what was the main point of Mr. Troy's statement -- that art seems to comprehend more nearly the whole. I have said "seems" deliberately and without fear; for within the realm of science as well as of art what seems is the essence of the conclusion.

We live hourly by what seems true, good, or beautiful, or their opposites; underlying all our behavior are conscious or unconscious apprehensions. These apprehensions take shape in scientific hypotheses and lead to all manner of technological achievements and cultural changes; they also take shape in religions and philosophies and works of art. A bridge-designer apprehends certain forces in the world of nature and his bridge takes shape in his mind in terms of those forces: we trust him to build our bridges because of his experience in working with things in those terms. The result is one kind of satisfaction which is part of our intelligent adjustment to the world. John Marin apprehends his bridges in another set of terms and paints them.

Our support of such artists by no means shows that we ask them wholeheartedly to give us their aid in adjusting to our world, but they give the aid just the same and we take it or leave it. What actual part in our adjustment to our world such artistic contemplation plays depends upon each person's nature and conditioning.

Without assisting in the building of bridges, it does for some people provide satisfactions of another sort. Those satisfactions are the proper subject for the scientific psychologists' investigations and for the ethical tests of philosophers and of every individual ethical being. Like the way of science, this way of contemplating things has developed out of some need in human beings in their environment and will last just as long as the need persists. The only danger in the pursuit of one sole way of contemplating the world is that men will lose the capacity to satisfy fundamental needs in other ways.

Two warnings against that danger are all that I can call your attention to at this time; one the actual experience of John Stuart Mill, who recounts in his Autobiography the attempt made by his father to make of the boy a complete scientific and rational machine and the near disaster to his life and usefulness as a scientist; and the other, the fictional character Gradgrind pilloried by Dickens in his novel "Hard Times".

Those phrases "the whole man", "the whole experience of life", and the like, are the verbalisms for what people interested in art seem to their satisfaction to get from the artist's way of contemplating the world. Consequently we respond to the slogan with a great lift, because it is our way to respond emotionally and to words. But I should expect that such a concept as "wholeness" or "totality" would appeal to the rational scientist as well, if for nothing better than that such a conscious experience must be part of his data.

CONCLUDING REMARKS

Lewis W. Jones

I shall not attempt any exhaustive (and exh&usting) summary of the discussions of the last two weeks. I should like, rather, to emphasize one or two of the significant ideas which have emerged, and to deal briefly with one or two of the more persistent questions which have arisen.

First, I want to express the appreciation of the entire panel for the really admirable cooperation and stimulation you have given us. Mr. Lundberg places proper emphasis on the usually underestimated capacity of human beings to suffer, but we still had not anticipated such endurance on the part of the Bennington community.

By all odds, the most significant aspect of these meetings has been the united front of the science and social studies faculties. The purpose of this cooperation is two-fold; to learn from each other, and to demonstrate to you the inter-relatedness of our respective fields of knowledge. At least in the first part of our purpose, we have succeeded. We have learned a great deal from each other, and have thoroughly enjoyed the agonies of thought together. The fun we have had, I may say, has not all taken place on this platform. I refer also to the orgies of discussion and speculation which have gone on under less formal circumstances and without the restraints and responsibilities of an audience, and rigorous time limitations.

I hope we have also succeeded in our second purpose, that of persuading you to think of the divisions separating the various sciences and social sciences as arbitrary divisions, and of emphasizing their essential unity in a common method, and common ends. Science is social, and will flourish best when it recognizes that fact; society can be fruitfully studied by the use of the method which has yielded such remarkable control over our physical environment. Though many people will give ready assent to the idea that the lines between the various scientific fields are merely lines of convenience, most of us are subconsciously bound by them, and seldom overstep them. This is particularly true in education, and you will unfortunately find students of political behavior sublimely indifferent to the findings of economists, economists using psychological concepts long since discarded by scientific psychologists, psychologists too ignorant of biology, biologists of sociology. That this united front of ours should be worthy of remark, that the position we have presented is not commonly to be found among college faculties, is a fine example of the cultural lag to which Mr. McCamy and others of this panel have referred. I mention this, not to call attention to any remarkable originality on our part, because, after all, the stand we are taking is a logical and inevitable outcome of advanced thinking in all our fields.

What is remarkable is that we are operating in a College which is so planned and administered that this logical step can be taken without the resistance of an established academic tradition.

Next, I want to refer back to the opening meeting in this series, and pick up the thread of my discussion of the scientific method. It is of course inevitable that any opening statement in such a series of this should be partially misunderstood, if not completely forgotten. Such misunderstandings as result from loss of memory can of course be cleared up by a re-reading of the papers which have been given. Let me repeat that the scientific method is a method of investigation, a tool for the acquisition of valid generalizations, of true guides to action, based on the processes of hypothesis, experiment, controlled observation, and careful checking of results. It is an implement of, and in no sense distinct from, rational thought. It includes the logical methods of induction and deduction, and is characterized in addition by continuous questioning of conclusions and of basic assumptions, continous striving to remove the personal bias of the observer and to improve the instruments of precision. No claim has been made, as Mr. Fergusson seems to suppose, that scientific techniques of measurement comprise the whole of rational thought. They are instruments of rational thought. In every field of scientific investigation, techniques must be devised, symbols and constructs invented, which will fit the particular abstraction the scientist is making. But whether he is operating in physics, biology, or sociology, the rational methods of induction, deduction and the other logical tools will be common to all scientific fields.

So much emphasis has been laid on the usefulness of the scientific method, and especially the development of techniques of quantitative measurement, that I want to redress the balance, if I can, by emphasizing scientific thinking, as distinct from scientific investigation. Evidently, few of us are prepared, by inclination or training, to engage in scientific investigation. We haven't the techniques, and most of us tremble at the thought of acquiring them. But whether we are musicians, painters, interior decorators, veterinaries, or wives and mothers, we may all be scientific thinkers to the extent that we use the consensus of informed scientific opinion as the basis of our thinking. Thinking scientifically means thinking logically, accepting the authority of scientific knowledge. Our acceptance of that authority is of course a cultural phenomenon, and derives from our observation that scientifically arrived at knowledge has been demonstrated as valid in countless ways affecting our everyday lives. We accept it very generally in dealing with mechanical problems, and call the electrician rather than the theologian when the lights fail.

Few people have begun to think scientifically in social and economic affairs. They rely on their own uncriticized observation, colored, as Mr. Lundberg has said, with the animism of primary group experience. I will not grant the term "rational thought" to any thought professing to deal with human affairs, if it consistently ignores the scientific knowledge of man and society which has already been established. It is the serious lag in our social thinking which contributes to the spread of such grotesque forms of political behavior as Fascism, National Socialism, and War.

Before leaving this subject of scientific thinking, I should like to take up more specifically some of the criticisms presented by Mr. Fergusson. Mr. Fergusson seems to find some implied opposition between rationality and the scientific method; I have already said that the scientific method is one of the tools of rational thought. The scientist does not, however, confine himself to logic and dialectic, but implements his logic with careful induction based on controlled observation. If Mr. Fergusson had only supplemented his deductive logic by an inductive examination of my paper, he would have avoided the error involved in assuming that what I said was what he expected me to say by deducing my statements from his preconceived notions of what deluded scientists think about science. Mr. Fergusson goes on: "The scientist is in a special relation to his method: it gives him something to do with his life, and the technological results of science assure him daily that he or his kind are of some significance. It is perhaps natural that he should not ask, even when discussing science and culture, whether his faith is in the redemptive function of science, or in the mechanical nature of the universe, or in reason."

Again, I should like to suggest that unaided deduction is leading Mr. Fergusson astray. If he would take the trouble to examine the writings of contemporary scientists, he would find them perfectly aware of their assumptions, their metaphysic, and the tenets of their faith. If he had read to the end of my quotation from Thurstone, some of his wonderings about the faith I mentioned might have been answered. I quote again: "The constructs in terms of which natural phenomena are comprehended are man-made inventions. To discover a scientific law is merely to discover that a man-made scheme serves to unify and, therefore, to simplify comprehension of a certain class of phenomena. A scientific law is not to be thought of as having an independent existence which some scientist is fortunate enough to stumble upon. A scientific law is not a part of nature. It is only a way of comprehending nature." The naive mechanism which Mr. Fergusson has assumed to be the unconscious metaphysic of the scientist is a product of his own unaided deduction.

As to the fourth belief which Mr. Fergusson intuitively discerns in our hearts: the belief that all the problems of humanity will eventually be solved by the scientific method. Again, I do not recognize the belief. It is incompatible with the assumptions of science which takes change and process as continuous. Mr. Fineman has more accurately represented the attitude of the scientist in stressing the continually expanding boundaries of knowledge, which in turn continually extend our awareness of the things still unknown. The assumption that any scientist would make the ridiculous statement that the arts also, cookery, the drama, music, would be regarded as fancies permitted to our ignorance but without relation to what really exists, and unnecessary to the "well-adjusted" individual or society, shows a rather complete misunderstanding of most of what has been said here. Obviously, the sciences are useful only as they contribute to the various practical arts. Dr. Osborne's paper dealt with the achievements of the art of medicine. Moreover, Dr. Osborne has said, in one of the discussion periods, that the concept "well-adjusted" is an artificial one, that no one, be he scientist or artist, will ever be perfectly adjusted. All we are hoping is that the art of politics may ultimately come to be based on scientific knowledge about human society, just as the art of medicine is now based on scientific knowledge about the human body. Indeed, we may hope ultimately to see a much more admirable art of living based on a greater scientific knowledge of man.

Another persistent question has been on the conflict between science and religion. It seems to me that Mr. Fowlie's excellent statement puts the matter beyond argument. It is clearly a case of conflict in authority: the choice is between the acceptance of the authority of the Catholic Church, or the acceptance of the authority of the scientific method. Once the issue is clearly stated, it is obviously profitless to argue: the two positions differ in their basic assumptions, and these basic assumptions are not susceptible of absolute proof. The scientist does not, or should not, make dogmatic statements about the truth or falsity of either belief. His position is an agnostic one, since he has no way of knowing whether or not there is a supernatural world. What he does say is that the assumption of supernatural phenomena, somehow interpenetrating and affecting the natural world, is not a fruitful or necessary hypothesis in his scientific study of man; and that it is in certain respects incompatible with the pursuit of his method. He, therefore, rejects it. If these religious beliefs are found to be perfectly compatible with the experience of any member of this audience, we have of course no interest in undermining them. What we have tried to point out is that the cultural conditions of our time are favorable to the continued spread of the scientific method of thinking, unfavorable on the whole to the general acceptance of theological beliefs.

An old friend among the questions is that which seems to seek the answer that science and art are somehow antagonistic. I had hoped that the excellent statements of Mr. Park and Mr. Hirsch would have settled that false antithesis. Art uses methods other than those of science, because its purposes are different. We could, if it were appropriate, give you an elaborate analysis in sociological terms of the functions of art in our own and other cultures, or of its psychological functions in the life of the individual. We should, of course, make no attempt to tell you, by quantitative measurement, whether a work of art is or is not beautiful. All we could offer would be some comparative study of standards of beauty, some psychological analysis of the processes of judgment. I should like to say in passing that Mr. Troy's statement of the role of art in dealing with the totality of experience is entirely compatible with what has been said on this platform. Science abstracts from totality, chemistry makes one kind of abstraction, physics another, psychology another. None of the sciences makes any claim to a complete representation of any concrete phenomenon.

Lastly, we come to the question of values. I think most of the confusion which has arisen is due to our emphasis on the <u>method</u> of science, which is, of course, neutral and non-ethical in <u>its</u> conclusions; this has somehow become identified in your minds with the notion that the scientist, unlike other men, is incapable of and unconcerned with value judgments. All we have said is that a chemical law is a generalization which implies no guarantee that it will be used well or ill; put a physician and a confirmed poisoner in a laboratory, and if each has had a good scientific training, each will read identical results by conducting the same experiment. The scientific knowledge both achieve is impersonal; the use to which they put it may be quite the opposite. The scientist, or the man trained to think scientifically, is, of course, just as much an ethical being, just as much motivated by warm human feelings and aspirations toward the good, as the rest of mankind.

If you want a more specific declaration of moral values, I am willing to tell you that the social scientist can hardly regard them as anything but social. Good and evil have no intelligible meaning unless they can be discovered in operation, in behavior. We, therefore, look for moral values, not in a separate "ideal" world into which we have projected desires growing out of dissatisfactions with our social experience, but in the dynamic relationships of everyday living. We, therefore, believe, that any responsible morality imposes on us the obligation to seek to understand and remedy the conditions which make the lives of our fellow-men less than human. We accept with enthusiasm the ethical goal of humanism as put forward by Mr. Troy: we want, as citizens and human beings, to use scientific knowledge to enhance the dignity of human life. We want to develop techniques which will eliminate war, civil war, unemployment, and all the other manifestations of fear, hatred and unreason which constitute remediable public nuisances.

In conclusion, I should like to endorse Mr. Troy's statement that "No value can be made generally operative until it has been taken up and absorbed into a whole system of ideas. I, therefore, propose that the immediate task of philosophy is to construct such a system of reformed humanism that it is the task of political government to give us a world in which such a re-assertion of man's dignity will again be possible, and the task of economics to make concrete and practical this possibility." To this I would add, that it is the task of education to accelerate, as far as possible, the new cultural synthesis which may emerge by the inculcation of the scientific habits of thought upon which such a synthesis must depend.