THE

American Scholar

A QUARTERLY FOR THE INDEPENDENT THINKER

PUBLISHED FOR GENERAL CIRCULATION BY PHI BETA KAPPA

In the right state the scholar is *Man Thinking*
—EMERSON

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THE AMERICAN SCHOLAR

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Editorial

This special issue was conceived last July on the fair island of Chappaquiddick, just off Martha's Vineyard. Our week-end guests, John and Mary Ellen Johansen, were continually maneuvering to take possession of one book. I asked Mr. Johansen about it.

The book was Marshall McLuhan's *Understanding Media,* and Mr. Johansen, who is a distinguished architect, said that until he'd come across this book he had thought he was living in the present. "But now I know I'm way behind," he said. "There's a whole world out there that I've only begun to have a look at."

It was then that I decided there must be such an issue as the one that follows. Preparing it has been difficult, but not so difficult as it would have been had not a great convocation been held at Southern Illinois University last October. This conference, Vision 65, was the first of its kind. It was sponsored by the International Center for the Communication Arts and Sciences. The Center's President and Program Chairman of Vision 65, Will Burtin, declared, "This congress takes place at a time in history when fundamental social, intellectual and technological developments reshape the substance and meaning of reality. Every facet of our lives is affected and every value requestioned, as a steadily mounting pressure on the individual and on society is recognized."

A little later in his opening remarks, Mr. Burtin went on, "The first prospectus of Vision 65 stated that 'the time has come when we must question the continued usefulness of a principally opportunistic and essentially planless attitude toward content, employment and design forms in mass communications . . . The time has come for the professional practitioner to review implications of his work as well as the standards and values on which it is based.' " And finally, "Technology has made the world smaller and people interdependent. Conversely, the importance of communications has grown beyond any measure conceivable earlier. Their intellectual and esthetic improvement is now the major requirement for human survival and growth."

Through the cooperation of the Center, the contributors to Vision 65 and Southern Illinois University, THE AMERICAN SCHOLAR received permission to publish a number of these papers in the present issue. In some cases, we have deliberately left the original address form of the piece, in the interests of flavor. Among these is one by that astonishing man, R. Buckminster Fuller. I find it imperative to digress at this point, to pay tribute to him and to one

of my colleagues, that longtime member of our Editorial Board, Harlow Shapley. Some twenty years ago (a little more, a little less), Dr. Shapley proposed at a meeting of the Editorial Board that we invite "Bucky" (as he called him) Fuller to write an article for us. "I suppose," he said, "that he's the brightest man alive."

There was a chorus of protest. "Crackpot" and "eccentric" are two of the terms used to express disapproval of inviting Mr. Fuller. Dr. Shapley's rejoinder was that these terms had also been applied to Jesus and Galileo and Einstein. But he did not prevail. Only now at last are we honored by having Mr. Fuller as a contributor.

Even now, much to our regret, through (ironic!) a failure in communication, we have only Mr. Fuller's concluding remarks at Vision 65. He also gave the keynote address, which is available to anyone writing to THE AMERICAN SCHOLAR and asking for it.

As plans for our first "electronic number" progressed, we continued to be fortunate. Phi Beta Kappa and Sigma Xi chose for their speaker at the joint December meeting of the American Association for the Advancement of Science J. Bronowski, whose topic was "The Logic of the Mind." Tradition has it that both THE AMERICAN SCHOLAR and *The American Scientist* publish this annual address. But this time it fitted beautifully into our planned Spring number and added a new distinction.

Other contributors were proposed by members of the Editorial Board, and we were again fortunate in the numbers of those who accepted. Lynn White, Jr., and Robert McClintock arrived in a state of innocence. Their papers, which appear in this number, were submitted, so far as I know, without any knowledge that there was going to be such an issue. Each was enthusiastically accepted.

Finally, at an AMERICAN SCHOLAR staff meeting, someone proposed securing an eminent American who had no direct connection, no specific training in the new techniques, but had played a role of importance in some field of mass communications, to read these pieces in advance and introduce the issue to its readers in a less limited way than this editorial can. We chose that veteran and pithy journalist and historian Gerald W. Johnson, formerly of the Baltimore *Sun,* one of the wisest men I have ever met.

I have the shivery feeling that by the time this number reaches your hands some of it may well be obsolete. But to revert to Mr. Johansen, I have at least the illusion that this is the nearest I have come to living in the present.

HIRAM HAYDN

ous historians like Philippe Aries; historically, the child came out of the seventeenth century, did not exist, so to speak, in Shakespeare's day. The child had, up until that time, been so completely merged in the adult world that there was nothing that could be called childhood in our sense at all. And so it is with the family, another seventeenth-century discovery. Suddenly today the child is merging with the total adult environment under electric information processing, and is disappearing from the scene as child.

The future of child may resemble the future of city. The city under conditions of very rapid movement takes on a totally new meaning. The motor car has served to destroy the city as it existed under the railway conditions. The future of city may be very much like a world's fair—a place to show off new technology—not a place of work or residence whatever.

It is also fascinating to consider the future of language. We know right now some very important structural things about language that are new. The future of language will not be as a system of classified data or meanings. The future of language as a complex structure which can be learned without learning the words at all, is a possibility that the computer presents increasingly. A child does not learn language as a series of meanings of words. He learns language as he learns to walk, or to hear, or to see. He learns language as a way of feeling and exploring his environment. Therefore, he is totally involved. He learns very fast because of this enormous sensuous involvement and the resulting motivation. It will be possible in this generation, I hope, to program the environment in such a way that we can learn a second language as we learned our mother tongue, rapidly and totally, as a means of perception and of discovery. The future of language presents the possibility of a world without words, a wordless, intuitive world, like a technological extension of the action of consciousness.

I had a friend visiting from Harvard the other day who said: "You see, my generation does not have goals." (He is a young architect.) "We are not goal-oriented. We just want to know what is going on." Now that means not a point of view but total ecological awareness. I was reading aloud from *Finnegans Wake* for a moment, and he said: "When you take L.S.D., the whole world takes on a multidimensional and multisensuous character of discovery, and when I listened to *Finnegans Wake* I got the same experience as L.S.D." (Perhaps *Finnegan* would be safer, and also more rewarding.)

The point this person was making was that it is absurd to ask us to pursue fragmentary goals in an electric world that is organized integrally and totally. The young today reject goals—they want roles—R-O-L-E-S—that is, involvement. They want total involvement. They don't want fragmented, specialized goals, or jobs. Now that is not easy to explain or to prescribe for.

I have touched upon the future of language, the future of consciousness, the future of the city, the future, perhaps, finally, of work. As a form of organized human activity, work is undergoing the most drastic changes of all; and there is nobody in the world who knows more about this than the great man sitting down here in front of me who has had a most paralyzing, I am afraid, effect upon my endeavors this afternoon, Professor Buckminster Fuller. I thought of a phrase I came across recently, "Home is where you hang your head." Now, to have in front of me in an audience a man like Buckminster Fuller makes me feel terribly at home in that sense. I really feel shatteringly humble. I am grateful to you for your most genial attention. Thank you.

Vision 65 Summary Lecture

R. BUCKMINSTER FULLER

I have never been in a large conference at which I've felt as intuitively intense as I feel right now at this one. My intuitions tell me this has been an extraordinary meeting of human beings. I speak with the experience of many meetings—of human beings brought together because of their eminence in all manner of unique performance patterns. Their strength and variety gave hope that they would be able to contribute importantly to the answering of great questions.

The meetings of the last few years have been organized to address great questions, particularly on the forward implications of the impact of technology on world society. However, few, if any, answers of importance have developed.

At this Vision 65 Conference at Southern Illinois University, the whole set of circumstances seems to be extremely propitious for the formulation of some important realizations. Southern Illinois University was approximately unheard of until about nine years ago. It wasn't even a university until Adlai Stevenson as Governor of Illinois converted it from college to university status. It has, however, been in existence for almost a century, as a very small teachers' college, going back to within a few years of Abraham Lincoln's day in southern Illinois. Stevenson anticipated the flooding need for higher education facilities, so he created several universities, in the north, east, west and south of the state.

Southern Illinois had become a completely forgotten part of America. It dropped out of sight when the great north-and-south river traffic that plied on the Mississippi, Ohio, Missouri and Illinois rivers—all finally merged into one at the lower extremity of southern Illinois—was suddenly replaced a little over a century ago by the new era's east-west railroad, which crossed Illinois, from Chicago to St. Louis, well over a hundred miles north of Carbondale. So this very remote place in the heart of America was almost entirely forgotten except for its mine labor riots at Herrin, a half century ago.

Now southern Illinois comes into world prominence again as the place where it is the working assumption of a classless democracy that all of humanity should have the opportunity of an advanced university education. As S.I.U.'s President Delyte Morris has pointed out: it is the assumption here that "dropouts" indicate inadequacy of the educational system and not of the human individual.

I am certain that none of the world's problems—which we are all perforce thinking about today—which are also central to this conference—have any hope of solution except through society's being thoroughly and comprehensively educated, and thereby able to identify and communicate the vital problems of world society, and thereafter to sort and put those problems into order of importance in respect to the most fundamental principles governing man's survival and enjoyment of life on earth.

My intuitions are vigorous regarding the present alertness and almost apprehensive awareness of the particular human beings who have come here to this Vision 65 S.I.U. meeting from all around the earth. I have met many of the participants in other parts of the world; I know that the group who have come together here are unique. They are of the one-in-one-hundred-thousand type of thinker, who is realistically earnest in trying to find ways of making humanity successful. They have learned how to take the initiative. They

✪ R. BUCKMINSTER FULLER, designer of the geodesic dome and architect for the projected United States Pavilion at the 1967 World Exhibition in Montreal, has been a professor at Southern Illinois University since 1959.

don't need or want to be told what to do. My intuitions tell me, therefore, that this meeting is an unusually successful harvest of capably responsible human beings. I think it interesting that we have avoided negatives and that much that is useful and promising has been said about the functions and functioning of communication.

I often play a mental game, which I started a great many years ago. I patterned it after the physical discipline, with which all humans are familiar, of lifting progressively heavier weights on successive days, thus gradually to become more physically powerful. When I started playing my mental game, my scheme was to ask myself a little larger and more difficult question each day. I also gave myself a basic playing rule, that I must always answer the questions from my own direct experience. I have been playing that game for a long time. Finally I came to the question: What do you mean by the word "universe"? And I said to myself, if you can't answer that question, you must give up the use of the word universe, because you are being deceitful to yourself and others by suggesting that it has a meaning. Following my own rules, I gave myself the answer: Universe is the aggregate of all humans' consciously apprehended and communicated (to self or others) experiences. Because I had answered in terms of experience, my definition has withstood all subsequent testing by myself and others. I haven't been able to find any thinkable aspect of universe that has been overlooked. We have experiences of dreaming, falsification, multiplication of the numbers of words in the dictionary, and so on. I don't find any experiences that are not included in the definition. So, for the time being, I go along with that definition. It has been fruitful.

Playing the same kind of game and starting with universe as defined, I found that the universe definition included metaphysics because metaphysics deals with thoughts which are weightless. The physicist defining the physical universe (Einstein's famous definition) had deliberately excluded metaphysics because they are imponderable. So, I found it interesting that I had a definition that also included the metaphysical universe—of mathematics, thoughts and dreams as realistic experiences. And because all of my experiences had beginnings and endings, they were finite. I said, therefore, that the aggregate of finites must also be finite. Therefore, the universe, including both physics and mathematics, is finite.

In playing that kind of game I now had the advantage of being able to start not only with total finiteness but logically—as men, lacking a definition of the whole universe, had not been able to start logically before. This gave me many advantages, for the whole system was finite. I thus came logically to some mathematical discoveries regarding the thought processes. I would like to give you a simple way of looking at things, which I found appropriate once one starts with a definition of the finite whole.

I also found this process of working with finite logic from the whole to the particular to be a very effective kind of strategy in trying, for instance, to think our way through to understanding what our human function in the universe might be. I found that, when I was confronted with a vast question and an enormous amount of material and experience, one of the first things I always tried to do was to make a basic division of the universe and thereafter to subdivide the relevant parts into progressively smaller halves, always, successively, selecting the half most clearly containing—and therefore relevant to—the problem until I reached an understandable and very local level in universe. In developing the solution to complex problems in modern information theory, which governs the design of computers, this same principle of progressive subdivision and selection of the relevant half is used and each progressive subdivision is called a "bit" and the number of subdivisions totally required are known as "so many bits."

I found it is quite possible to subdivide the universe instantly by developing the concept of a "system." A system is a local phenomenon in the universe that is geometrically definable because it returns or closes upon itself in all directions. Systems may be symmetrical or asymmetrical. I

found that systems are the first subdivision of universe for they subdivide the universe into all the universe that is inside and all the universe that is outside the system. This divided the universe into the macrocosm and the microcosm. Then came the extraordinarily surprising and sudden discovery that this system concept led to an important understanding of—what we do when we think.

I am quite certain that thoughts are not bright ideas mysteriously inserted into a vacuum chamber in the head. I'm quite confident that what we do when we think is to behave as follows:

We dismiss the irrelevancies. I find that our brain is filled with constant reports and notices in which we're being told about various events around us. All of us have experiences saying to one another, "What's that friend's name? You know, the man we both know. We were with him for three years." And neither of us can remember his name right away. But we all experience suddenly recalling the name possibly five minutes later, possibly the next morning.

The main point is that there is a definite lag in the search to memory storage and its feedback and that there is a great variety in the rates of lag between some recalls and others that we have stored deeply. Because we do get such feedbacks, we are always receiving a great deal of feedback from questions we had even forgotten that we had even asked. On my way here today I looked at a tree and I said, "What kind of a tree is that?" And I asked many other questions as I went along. I am asking myself questions all the time; and because the lags are very different for the different kinds of memories, I find that when I am lying down in my bed and trying to go to sleep, I get report after report coming back telling me about things that I had asked questions about and forgotten that I asked them. At all times we are in almost chaotic focus of brain-dispatched messengers trying to come into our conscious thought pattern to give us the answer to questions we or others in our presence have asked. Therefore, I have discovered that what I do when thinking is to say, keep those messengers outside for a moment. That's very interesting. I am glad they're there, but please keep them outside because all I want to think about right now is this glass of water.

I discover, then, that thinking is *a momentary dismissal of irrelevancies.* That decision immediately gives you one of those enormous opportunities further to divide the residual definition into two. This is possible because irrelevancies fall into two main classes: all the events that are irrelevant because they are too big to have any possible kind of bearing on the particular focus of our thought, and all the irrelevancies that are too small possibly to build up any significant relationships to alter the focal subject of our thinking. You find that what you have been trying to think about has a definite experience and frequency magnitude. Thus we find that all the irrelevancies that are too small are dismissed inwardly of the thought about local system and, therefore, dismissed into the microcosm because they can't catch up to the magnitude zone of the wave length and magnitude that we are working on; and the irrelevancies that are irrelevant because they are too big to have any effect on our considered focal system of consideration, are dismissed outside the system, that is into the macrocosm.

I find that there are also a number of temptingly almost relevants, which I might bring into our consideration, which might persuade you to be interested in what I am trying to communicate to you. Thus I learn that there is a Twilight Zone of Tantalizingly Almost Relevants. There are two such twilight zones—the macro and the micro—tantalizingly almost relevants. Between them there is always a set of extraordinarily lucid items of relevance. And when I pay attention to those lucid relevances I find that the minimum set that may form a system to divide universe into micro and macro cosms is a set of four items of consideration. I see next that between four stars that form the vertexes of the tetrahedron, which is the simplest system in universe, there are six edges that constitute all the possible relationships between those four stars. When we have found all the relationships between the

number of items of our consideration we have what we speak of as "understanding." The word consider derives from the Latin words for *together* and *stars*. When we *understand,* we have all the fundamental connections between the *star* events of our consideration. When N stands for the number of stars or items of consideration, the number of connections necessary to understanding is always $\frac{N^2 - N}{2}$.

When I was invited to come up and meet with you now, I felt that I would like above all things not to allow myself to be affected by any conditioned reflexes that would make me say anything I had ever said before. I would like to think out loud as freshly as possible about the significance of this meeting. Our experience with Bob Osborn's cartoons gave us a good inventory of negatives. This doesn't bother me at all, because I am thoroughly aware of the experimental work done by nuclear physicists. One of their most important experimental findings shows that every physical component of the atom has its opposite, for example, the electron which is "negative" has its positron. Every positive has its negative and vice versa. The negatives of all those having positive weights have negative weights. This means that the average of all the weights of all the fundamental components of universe is zero. Although dealing with a universe of average zero weight, we find by experiment that we are (almost) always dealing with the positive or the negative which is our reality. We are dealing in a complex of pure principles that include a variety of time lags and thus create time and life as experience. This is an intellectual experience. Everything we cerebrate has to do with the principles such as lag, angle and frequency. I am never concerned when some people concentrate on enumerating negatives, because I know that each has its positive.

As noted, I must always go back to my own experiences for answers and my own experience inventory is short. It is only seventy years. But in that seventy years, I have experienced some extraordinary changes. The life insurance companies' mathematicians, dealing with all of mankind's vital statistics, are able to determine the probable "number of years that people born in a given year will live." This lifespan is known by the insurance companies as the expectancy of individuals born in the given year. Expectancy for females usually is greater than for their contemporary males. My expectancy at birth was forty-two years. That was all that an 1895-born male was supposed to live. But conditions governing man's health and welfare improved rapidly, and expectancy began to advance at an historically unprecedented rate, so I have not yet caught up with expectancy.

The average distance that human beings could travel on their feet or in vehicles in their respective separate lifetimes up to and including my father's time was an average of thirty thousand miles. In my lifetime I have already swept out three million miles, which is one-hundred-fold the distance of all our forefathers. Now I am one of a class of several million men who have experienced three million miles around our earth. Our ecological pattern has clearly changed, and changed abruptly, from all the generations before us. Now the aviators and air hostesses make much more mileage than I do and each of the two Gemini astronauts knocked off my three million miles in one week of orbiting. Quite clearly man is moving into some very new relationship to his physical universe on a pure physical assessment basis. I recall my first pre-World War I jobs and working with men admirable for their strength and physical courage. I found I could win their friendship, but I was appalled at their mental inferiority complexes. Very few of them had gone to school for more than a few years, almost none had gone to high school, let alone finished. Very rarely did I meet anybody who had gone through college. My fellow workman was intellectually timid to a fault. He was a slave; he knew he had very little chance of happy and healthy survival. He was afraid of his words and his mind. He communicated his feelings by the way in which he chewed tobacco, spat and blasphemed, using a total vocabulary of no more than about fifty words.

This was the everyday experience of all times for ninety-nine percent of humanity. Shakespeare and the historians write only about the doing of the one percent. The history of the ninety-nine percent is the same as the history of cats and dogs, who usually fared better than men. Yesterday this southern Illinois town of Carbondale was just a strip-mining coal town, where tobacco was chewed and spat, accompanied by the fifty-word vocabulary. These conditions have all changed in an extraordinarily short moment—in less than my lifetime. Here at Southern Illinois University are twenty-one thousand young people—probably very greatly affected by the radio and television in their childhood environments—to whom a good vocabulary is obviously and happily desirable. You have come to us from all around the world, speaking and organizing your thoughts with great integrity and without intellectual fear of your fellowman. But, in my memory humans, of the same origins as those of any S.I.U. student, who dared to speak a well-formed sentence were whistled at and treated as being some kind of sexual deviates. I know by personal experience that the world has changed and is changing at an ever faster rate.

When I was young going from a little town seven miles outside of Boston into Boston through Dorchester, or Roxbury, I saw that all the children in the streets were in rags. No exceptions. People on the trolley really stank. Women of twenty-six years were hags with half their yellow teeth out. There was no dentistry for them. It is my own direct experience that life has changed very much for the better.

Clearly, and sum totally, something very important is happening to man on this planet. Fred Hoyle, the great astronomer, dealing with the regularities found by astrophysicists in the heavens, has been able to say in all seriousness that he now assumes from the observed regularities that there are at least hundreds of millions of stars with planets that could maintain human life. He finds it logical to assume human life to be present in this universe on at least one hundred million planets. This particular big figure he uses is obviously intended to infer astronomical numbers of humans present in universe.

Dr. Hoyle—who is the Plumian Professor of Astronomy and Experimental Philosophy at Cambridge University in England—finds the case of humans on this particular planet to be precarious. He says humans have found atomic energy just in time to overlap the exhaustion of the fossil fuel supplies. Humanity will have to make other vitally important moves in a hurry.

I remember asking myself in my game of big questions whether there is anything in our experience that could tell us whether man might have an essential function to perform in the universe. Was he needed in the universe? Or was he—as he seemed to feel himself—just a chance observer, a theatergoer watching a great play called life. I said the only way we can judge whether he has a function or not is to go to our experimental data, and the way it came out is as follows.

With the development of steam, which could propel their ships when there was no wind, the great pirates, who mastered world commerce, saw that science could greatly advance their power, so they put up great amounts of money to back further scientific inquiry. The scientists developed the laws of thermodynamics and showed that energy continually and *always* escaped from local systems. Systems were always running down. This inherent energy dissipation was called entropy. The mathematicians described entropy as the *Law of Increase of the Random Element.* This concept is manifest by Sir Isaac Newton, when he said in his first Law of Motion, *A body persists in a state of rest—or in a line of motion* [clearly a secondary thought]—*except as affected by other bodies.*

"At rest" was the great norm. All the scientists went along with the second law in assuming that energy is leached out of the universe and that in due course the universe must run down and become motionless and dead. Life was abnormal and death was the normal state.

I entered Harvard University in 1913 just before World War I began. The Harvard community, and, in fact, Boston's large community of intellectuals, all assumed a

universe that would ultimately run down, and that the earth had been spun off from the sun and would finally stop spinning. It is a very short time since people were thinking in that way. But in this century the scientists experimenting with entropy began to discover that when energy left one system it could only do so by joining another system. It did not go out of the universe. They found that energies were always one hundred percent accountable. This forced them into a completely new law, the Law of Conservation of Energy, which says: Energy cannot be created, and energy cannot be lost. Energy is finite. This eventually brought about Einstein's finite physical universe.

Einstein found himself confronted with this new way of looking at energy and also with the extraordinary experiments that disclosed the speed of light—experiments made not only in relation to visible light but to invisible radio signals, that showed that energy released *in vacuo* was moving at 186,000 miles a second.

Einstein felt forced to think about the universe in a different way from Newton. He said that inasmuch as no energy could be lost, then the universe could not "run down," and "at rest" was not normal. He then assumed a universe of continual transformation and its acceleration normal. He further assumed that normal velocity is the speed of radiation unfettered in a vacuum —186,000 miles a second. While that is very fast, he pointed out that it is not *instantaneous*. Einstein then pointed out that the universe is a complex of nonsimultaneous events, and because there is no inherent composite "picture" of nonsimultaneous and nonidentical events, there can be no possible unit and static conceptual picture of universe. "What is outside the outermost stars?" is a meaningless question. Thus Newton's simultaneous, all interlinked mechanical universe became invalid and obsolete.

The brightest star that we use in our navigation is Rigil Kentaurus. And Rigil Kentaurus is four and one-half million light years away and is of a brightness magnitude characteristic of the stars that burn out in a million years. Quite probably Rigil Kentaurus hasn't been "there" in the sky for three and one-half million years. We only have evidence about man being on earth for about two million years. In seeing Rigil Kentaurus, we are looking at a "live" show taking place two and one-half million years before man came on earth. In looking at stars in the heavens we are not looking at simultaneous events. There is no outside to what is not there. Our thinking gets an entirely new breakthrough with Einstein. In the philosophy of relativity Einstein postulates an all transforming universe, constantly transforming at various rates. He next hypothesized that although energy was traveling normally at 186,000 miles per second, it could be going around locally in knots and that it could be so local as to be confined to atomic patterning dimensions and that the tighter the heavier, and this resulted in his famous equation of $E = mc^2$ which fission a quarter century later proved valid as accounting for the amount of energy in any given mass.

There is now a very large inventory of ways in which man has been teaching, thinking and accounting events and values which have no experimentally demonstrated validity. There is no experimental proof of such phenomena as straight lines, solids and planes. There is no instantaneous phenomenon. The word is meaningless. The senses and brains of approximately all our scientists are disconnected from their theories. Scientists see the sun "going down" when they have known theoretically for five hundred years that it isn't "going down." Although our senses are not geared with our advanced knowledge, man has been getting along in a gradually more favorable way. His communication is no longer confined to the mode of his spitting.

Man is born utterly helpless and remains utterly helpless for a longer period than the newborn of any other living species. That's quite an invention—an extraordinary complex like man born utterly helpless. It is valid only under the assumption that he will be taken care of. Although the helpless child often has drunken parents, fortunately gravity holds him in his bed, and fortunately some cow ate some grass and made milk and somebody got it out of the

cow and through a series of pourings by many people, it got into a bottle leading into the baby's gullet. It didn't come out of the mother's breast. In many ways, mankind is utterly helpless, vain and ignorant.

Human beings often say, "I wonder what it would be like to be on a spaceship." The answer is, "What does it feel like—you are and always have been on a very small spaceship, eight thousand miles in diameter." The nearest star Sun is ninety-two million miles away and the next brightest Rigil Kentaurus is not even there. You are very much alone in your spaceship. And this spaceship is designed so superbly, all its passengers so skillfully provided for, that they have been on board playing the game of self-reproduction for two million years without even realizing that they are on board a spaceship.

We see that all life has been able to succeed owing to the anticipatory design of a regenerative ecological energy exchange. The mammals give off the gases that are necessary to the survival of the vegetation, while vegetation gives off the gases that are essential to the survival of the mammals. None of them knows that he is contributing gratuitously to vital support of the other. I find that the earthworm is quite as irresponsibly, yet essentially, involved here, as is the bee. All of life is inadvertently and unconsciously involved. All of life has designed subconscious drives. Earthworms do the twist. But none of them realize the vital tasks they are doing for the others.

So I find all life interconnectedly successful and almost completely unwitting of the total ecological balance, which men sometimes speak of as "nature." The little bumblebee goes after his honey and his little fuzzy tail inadvertently knocks off and dusts pollen, which fertilizes vegetation. I think that is exactly the kind of pattern with which approximately all of humanity is preoccupied. I don't know any man who can stand up and say to us, "I am a success by virtue of having consciously designed, fabricated and operated myself, the biosphere, the sun, earth and all the intercomplementing ecology. I can tell you what I am doing with my lunch. I am sending off certain of this food to this gland and that gland, and I am going to use these differentiated energies in such and such ways."

We know humanity can't say that. Humans can't even tell you why they have hair. They certainly can't tell you that they are consciously pushing each hair out through their heads in special shapes and colors for special purposes.

We don't know anyone who knows much about what he is doing and why. Yet, one of the prominent, built-in behaviors of the occupational game-playing is the ego claimed credit for its inadvertent successes.

There are many indications, however, that man is just about to begin to participate consciously and somewhat more knowingly and responsibly in his own evolutionary transformation. I include evolution of the environment as a major part of the evolution of humanity. In his unconscious participation in the past he has carelessly ruptured his earth, polluted his air and water, corrupted his children in order to sell any kind of toy guns, dope, smut and anything that would make money, and has made all money-making sacrosanct. But if we discover that man is necessary to the invention of universe, we can understand somewhat better what he is inadvertently doing.

Some years ago, I asked myself whether man had a function in universe and if so, what it might be. My experience-informed answer went as follows:

The astronomers have given us their observation of the "red shift," which indicated that vast and remote star groups are probably receding from us in all directions because the light coming from them is redder than that from nearer groups, which in turn indicated an expanding universe. The expanding universe is also called for by the law of entropy or increase of the random elements which must ever fill more space. So I thought, we have also learned experimentally that unique behaviors are usually countered by somewhat opposite behaviors; therefore, an expanding universe would probably infer a concurrently contracting universe. So I said, "What experience do we have that may demonstrate such a contracting universe, even though none has

been observed or mentioned by the astronomers?"

I saw that around our own planet we have high and low atmospheric "pressures," which might better be called expanding and contracting atmospheric patterns. I discovered clues to the operation of a contracting universe to be operative as our own planet. Our planet Earth is not radiant. It is not sending off energy in any important degree. As compared with a star it is "dead." Earth is receiving energy from the sun but is not losing it at the same rate. For instance, we have learned from the Geophysical Year that we are receiving about one hundred thousand tons of stardust daily. Our physical imports from the universe are as yet much greater than exports. Therefore, we are a collecting or concentrating center, possibly one amongst myriads in universe. All planets in universe may be collecting points as focuses of the contracting phase of universe. At the surface of the earth, in the top soil, the ecological balance becomes operative. The vegetation's chlorophyll inhibits the sun's radiation instead of allowing it to be reflectively rebroadcast to universe. The sun-inhibited energy impounded in the vegetation is further inhibited by insects, worms and mammals, and both botanicals and zoologicals are gradually pressured into the growing earth crust and finally are concentrated into coal and oil rather than being broadcast off to universe in all direction. By dissipating these energy concentrations, man may well be upsetting the expansion-contraction balance of universe.

The ecological balance is fascinating when viewed chemically. We find all biological systems continually sorting and rearranging atoms in methodical molecular structures. To ensure performance each species is genetically and environmentally programmed. Each sorts and reassociates atoms as its genes cope with and alter environment, which in turn alters the species behaviors.

Thus we see that all the stardust, cosmic rays and other radiation randomly dispersed into universe by all stars are being methodically converted by the biological activity around Earth's whole surface—in the sea and on the land—into progressively more orderly "organic" chemical structures. Thus biological life on Earth is antientropic. Earth is acting as an antientropic center as may all planets in universe.

Of all the antientropic sorters and rearrangers on Earth, none compares with brain-driven man. We find man continually differentiating and sorting out his experiences in his thoughts. As a consequence we find him continually rearranging his environment so that he may eat, be clean, move about and communicate in more orderly and swifter ways.

Dr. Wilder Penfield is the head of the Neurological Institute of McGill University in Montreal, Canada. He is one of the world's leading electrode probers of the brain. The brain probers have now identified, for instance, the location of various memory banks. Dr. Penfield says, "It is much easier to explain all the data we have regarding the brain if we assume an additional phenomenon 'mind' than it is to explain all the data if we assume only the existence of the brain." Why? Because they have found, so to speak, the telephone sets of the brain, they have found the wires connecting the telephone sets, they have found the automatic message-answering service and the storage systems; but, a great deal goes on in the conversations over the wires that is not explicable by the physical brain's feedback. I have submitted what I am saying to you to leading neurologists and they have not found fault with it. A good scientist doesn't applaud you publicly or right away, even though he is favorably impressed with your theory. But he does let you know whether he objects to what you are saying and what his objections are. And so far there have been no objections and there seems to be some affirmation of what I am about to say to you.

We have a phenomenon that we speak about as a generalization. In science, a generalization is very different from a literary generalization. Generalization in a literary sense means that you are trying to cover too much territory with some statement. The scientific meaning is precise; it means "the discovery and statement of a principle that holds true without exceptions." I will give you an example. I am going to talk about a special piece of rope. I could have in my hands a foot length of three-quarter inch manila rope. But I can also say to you, "I am going to take an imaginary piece of rope," and I, not mentioning whether of nylon or manila, immediately generalize a rope concept from our mutual experiences. I am going to pull on that piece of rope and as I pull on it very hard it contracts in its girth. As it gets tauter, it gets tighter. This means that it goes into compression in its girth in planes at ninety degrees to the axis of the pull. I have found a great many human beings who think that tension is something independent of compression. I find experimentally, however, that tension can be only operative when compression is also present. A cigar-shaped vertical compression member that is loaded on its neutral axis tries to "squash." This means that its girth tries to get bigger. Which means also that its girth expands and is tensed. So I find that compression is never innocent of tension, but that they are cooperative in axes arranged at ninety degrees to one another. Sometimes I find tension, at what we call "high tide," or a highly visible aspect, and compression at "low tide" or at almost invisible aspect, and vice versa. We have here a generalization. We have found by experiment that "tension and compression only coexist." That is quite an advance over the first generalization just saying, "I take a piece of rope and pull it," which was a second degree generalization. And it is a third degree generalization when I say, "tension and compression only coexist."

A system subdivides universe into all of the universe that is outside the system and all of the universe inside the system. Every system, as viewed from inside, is concave and, as viewed from outside, convex. Concave and convex only coexist. Concave and convex are very different from one another. Convex diffuses energies by increasing wave lengths and widening angles. Concave concentrates energies by decreasing wave lengths and reducing angles. Although not the same and not exactly opposite, concave and convex only coexist.

In addition to tension and compression and convex and concave, I can give you a number of other such coexistences. This brings us then to another and further degree of generalization wherein we say that, "There is a plurality of coexistent behaviors in nature which are the complementary behaviors." That caused the mathematicians to generalize further. They developed the word "functions." "Functions" cannot exist by themselves. Functions only coexist with other functions. They are sometimes covariables. When I say, "Functions only coexist," I have gone a little further than the special cases of concave and convex or of tension and compression which were themselves highly generalized. Then I'll go further still and say, "Unity is plural and at minimum two." Which is the generalization that greatly advantaged quantum physics. We may go a little further in generalization, as did Einstein when he gave us his "Relativity." You can't have relativity without a plurality of cofunctions.

Now, I will give you another progression of events. You have seen a dog tugging at one end of a belt. He tenses it as he grips with it compressionally—with the concave and convex surfaces of his teeth. I am sure that you will agree that the little dog will never say, "*Tension* and *compression* only coexist," even though his brain coordinated them. The dog will not say, "*Concave* and *convex,* tension and compression are similar cases of coexistence of functions."

I think the neurologists go along with me in saying that, "What we mean by mind—in contradistinction to the brain of the animal or of man—is man's ability to generalize."

The ability to generalize—in its incipient phases—seems to me to be also a tendency to moralize. For instance, to say that, "If a man does so-and-so, he will get into trouble." I feel that in religious scriptures we come time and again to semigeneralizations showing how some men get into trouble and how you and your children may avoid such trouble.

We have seen how an enormous amount of special case experiences finally led to a progression of generalizations. There are

about six degrees of progressive generalization. As we went from the one case to another and to higher degrees, it was accomplished with fewer and fewer words. We finally came to just one word, "Relativity."

Now this orderly simplification happens to be exactly the opposite of the mathematician's *law of increase of the random element.* It is the decrease of the random element. Generalization is the law of progressive orderliness.

I found myself in 1951 having to write in a book, which I was about to publish, that the mind of man seemed to be the most advanced phase of antientropy witnessable in universe. And if there is an expanding universe there is logically a contracting universe. Possibly man's mind and his generalizations, which weigh nothing, operate at the most exquisite stage of universe contraction. Metaphysics balances physics. The physical portion of universe expands entropically. The metaphysical contracts antientropically.

It is interesting that within a few months after my publication of the hypothesis someone told me that Norbert Wiener had just published the concept also that "Man is the ultimate antientropy." I talked with Norbert Wiener about this and we found that we had both written this at approximately the same time—starting quite differently but coming to the same conclusion.

So now we have found a function for man in universe, which was our objective. Man seems essential to the complementary functioning of universe. Therefore the probability of humanity annihilating itself and thus eliminating the antientropic function from universe is approximately zero.

This does not, however, mean that man on Earth may not eliminate himself. It suggests that there are—as the Cambridge University astronomer, Hoyle, suggests—hundreds of millions of other planets in universe with men living on them.

This brings us to the observation also that to keep her ecological balance intact, when nature finds the conditions are becoming unfavorable for any of the "cog wheel" species necessary for the system, she introduces many more starts of that species. She makes enormous numbers of babies, enormous numbers of seeds of this and that tree when she sees that such trees are not going to prosper. The seeds multiply in number, float off in the wind, randomly distributed in order to increase the probability of an adequate survival number to keep the system in balance.

I also go along with Hoyle in his concept of the possibility of the enormous numbers of human beings on an enormous number of planets simply because not all of them are going to make a success of life on their respective planets.

Man is beginning to transform from being utterly helpless and only subconsciously coordinate with important evolutionary events. We have gotten ourselves into a lot of trouble, but at the critical transformation stage we are getting to a point where we are beginning to make some measurements—beginning to know a little something. We are probably coming to the first period of direct consciously assumed responsibility of man in universe.

I spoke to you on my first day here about the great challenge of our day. I showed that it was no longer true, as had seemed true throughout all history, that man was born purposefully to be a failure in all but one case in a thousand—with the latter semisuccess occurring only as an "exception that proved the rule." Throughout ages it was probable that the average human would die before reaching the average human's twenty-seven years—despite scriptural accounts of great longevity. There just was not enough known sustenance for humanity. At the beginning of this century there was not enough for more than one in a hundred to survive comfortably and "live out his days," meaning "four score and ten"—ninety years. Expectancy for males when I was born was forty-two. Half potential age. Under those conditions, dying slowly is not pleasant, so why not fight. Why not have a good quick battle with everything to win and nothing to lose —better than rotting in the slum. As I said in my opening address, we will always have war until there is enough of every essential to support all lives everywhere around Earth.

Every day, when it is available, each human consumes an average of two pounds of dry food, six pounds of water and inhibits the amazing figure of sixty pounds of air out of which he consumes six pounds of oxygen.

Food has often been very scarce, and often men have fought to the death for it. Water has sometimes been scarce and has been fought for. Air has rarely been scarce. Nobody has ever thought of putting a meter on the air for human consumption. But, we have had some terrible panics in theaters when there was a fire. Suddenly human beings—completely unused to competing for air—lose all reason, go mad and trample their fellowmen to death.

So I would simply say that there is nothing in our total experience that shows that when there is not enough to go around, it is illogical for men to fight to the death, because they are going to die anyway. There is also nothing illogical in the concept that when there is enough to go around men will not even think of fighting.

We now know scientifically that for the first time in history there can be enough to support continually all of expanding humanity at previously undreamed of and ever advancing standards of living and intellectual satisfaction in effective participation in the evolutionary processes. But we are frustrated from realizing our success by our different political systems and laws, which have all been devised to protect the few who have or have not adopted the system that promised the most in a bad bargain, or the most just system such as that which would provide for those whose labor produced the little that there was to go round.

I have made measurements in terms of work that can be done by human beings, measured by army engineers, in elevating foot-pounds per hours, days and years. From these studies I developed what I call an "energy slave" or the energy equivalent of the work a healthy human youth could do. The energy slaves in operation were determined by the amount of energies we were consuming from nature as waterpower, fossil fuels, wind, foods. Because up to now the distance that electrical energy could be delivered economically was only three hundred and fifty miles, industrial prosperity has been temporarily localized and has expanded only gradually. Therefore I took the total annual energy consumption of, for instance, the United States (of North America) for 1940 and reduced it by ninety-six percent because the machinery and processes used by man are of so overall low-grade design that he is only able to realize four percent of the consumed energy in potential effectiveness in the work accomplished. Despite this necessary reduction, I found that a very large number of energy slaves are working for humanity in our U.S.A. industrial economy. On the Eastern Seaboard of the United States in 1940 we had a hundred and thirty-five energy slaves working for each man, woman and child. And they were able to work continuously in extremes of heat and cold in which humans would swiftly perish. The inanimate slaves work with extraordinary precision at tolerances millionths finer than permitted by human sight.

I found, however, that an enormous proportion of all energy slaves' capabilities were going only into the development and production of weapons. Putting aside all the energy going into weaponry and retaining only that necessary to keep the people themselves going at a healthily high standard of living, I found that a family of five could be maintained at the high standard of living level with only one hundred energy slaves working for them in their economy—very few of the slaves work actually inside the house—they are employed in building the highways and keeping their telephone system in operation, *et cetera.* And this standard of living for a family of five produced by one hundred energy slaves was so high that it had not been known by any national sovereign before the twentieth century.

I found that in 1900 less than one percent of humanity were industrial "haves," but that changed very abruptly in and after World War I.

World War I witnessed intense mechanization of the world. In the year 1917, man took out of the ground, refined and put to work more copper than he had taken out of the ground in the whole cu-

mulative history of man's copper mining and refining. He did so because copper is essential to energy distribution. He developed such intense mechanization in World War I that the percentage of the total world population that were industrial "haves" rose by 1919 to the figure of six percent. That was a very abrupt change in history suddenly to have six percent of humanity surviving at a high standard of living. By the time of World War II twenty percent of all humanity had become industrial "haves" despite that the population was ever increasing. At the present moment the proportion of "haves" is at forty percent of humanity.

Consisting mostly of recirculating scrapped metals, eighty percent of all the metals that have ever been mined are still at work. And all those metals are now occupied in structures and machinery which operating at full capacity can take care of only forty-four percent of humanity; that is, they can take care of four percent more than are now being taken care of. During this twentieth century the combined amounts of scrap and newly mined metals per each world man has been continually decreasing because population is increasing faster than discovery of new ore bodies.

For man to go from less than one percent to forty percent, living at high standard—despite decreasing resources—cannot be explained by anything other than by doing more with less.

We find doing more with less has come about entirely through the unique technology of the less than one percent of humanity that cast its lot with life on the ocean to master the great commerce routes of the earth. They developed a technology that could float in contradistinction to the dry-land custom of protecting oneself with great stone walls—of which the greater the thickness and height, the greater the popularly-assumed security.

On the sea one couldn't use stone—one would sink. On the sea men took fragile materials such as wood that would float naturally and, by scientific designs, produced extraordinary and powerful ships with which they battled the seas and one another, seeking to control the great sealanes of world commerce, seeking to be the greatest power. They developed more and more speed, hitting power and cargo space with ever less of invested resources in time, material and energy per each and every function of the ship and its equipment and that brought them to steam and the steamship, brought them to steelmaking, to make the great ship. Half a century later they began to have enough steel left over from shipmaking to put some into buildings on the land. From the battleship to the land came electric dynamos, refrigeration, radio, desalination, *et al.*

To control the world even more effectively with the airplane forced an international race to do even more with less. In doing more with less we have recently gone, for instance, from the latest seventy-five thousand ton trans-Atlantic cable of copper wires to telstar, which provides more communication more effectively with less than a ton of materials. We have not been thinking correctly of this technological-do-more-with-less revolution as being only a by-product of our scientific preoccupation with weapons. But it is now obvious on study that this is what has changed man's condition on earth. It takes, on average, twenty-two years for the "dynamo to come off the battleship" into our domestic use. If we have to wait for twenty-two years to bring the curve of "haves" to one hundred percent, this may be fatally slow.

If humanity understood that the real world problem is that of upping the performances per pound of the world's metals and other resources, we might attempt to solve that problem deliberately, directly and efficiently. It might be a world around university students' elective research undertaking.

But I find that approximately no one realizes what is going on. That is why we have been leaving it to the politician to make the world work. There is nothing political that the politician can do to make fewer resources do sixty percent more.

Just what our communication problem is now becomes obvious. Man long ago invented communications because he had something to communicate. He was terribly hungry; and he only used communication when he had a vital need. He develops effective communication capability only when he has both an enormous need and a clear idea of what his problem consists. To keep aware of the progressively most critical problems of humanity one must keep an eye on a complex of economic and technical development curves. As I told you the other day, when Eisenhower was confronted by his atomic advisors regarding the enormity of the hydrogen bomb, he said, "There is no alternative to peace."

I will give you figures that will bring you to last week's U.S.A. inventory of destruction. For each one of us, in the U.S.A., there are now ten tons of steel and twenty tons of concrete and one hundred pounds of copper in use. But, for every human being on the face of the earth today, we have now twenty-eight thousand pounds (T.N.T. equivalent) of explosives—that's fourteen tons per capita, which is to say that for every pound of human flesh there are two hundred pounds of self-annihilating explosives. We must move swiftly to convert that energy from negative to positive advantage before an Oswald puts his finger on the trigger of the omni-inter-retaliatory atomic bombing systems. If we have to wait twenty-two years for high standard living to develop secondhandedly from weapons development, the probability is high that the Oswald finger will trigger human annihilation.

In addition to Eisenhower's "no alternative to peace," I go along with two other statements. A physicist of Chicago University, John R. Platt, surveying general world trends and basic data, says, "The world is now too dangerous for anything but Utopia."

Unfortunately, we now view Utopia as unfeasible. Our attitude is derived from the fact that all attempts to establish Utopias occurred when there wasn't enough to support more than one percent of humanity, whereas it is fundamental to Utopia that there must be enough for all. For the last ten years the by-product more-with-lessing of prime weapons development has made it visible that there can be enough to go around—handsomely.

I also go along with the statement of Jerome Wiesner, who was the White House Advisor to Kennedy and to Johnson during his first term. Wiesner is now back at M.I.T., where he is head of the department of nuclear physics. Wiesner says, "The armaments race is an accelerating downward-spiral to Oblivion."

So I'll say to you that man on earth is now clearly faced with the choice of Utopia or Oblivion. If he chooses the latter he can go right on leaving his fate to his political leaders. If, however, he chooses Utopia, he must get busy very fast.

For this reason I am excited over the earnestness of this meeting. Our intuitions are powerful in bringing our reasoning to bear. So, here we are, suddenly discovering what the real world problems are: So long as there is not enough for all of humanity to survive and enjoy total earth, there will be war.

We now know that Malthus is wrong and that there can be enough to go around if we up the performances per pound of the world's resources from the present overall mechanical efficiency of world societies' mechanics to a highly feasible overall efficiency of only twelve percent.

This can only be realized through a design science revolution of spontaneously coordinate university-aged youth. This revolution is trying to articulate itself everywhere. It gets bogged down by political exploiters of all varieties.

Making the world resources adequate can't be accomplished through political system competition. All politics are obsolete as fundamental problem-solvers. Politics are only adequate for secondary housekeeping tasks. Mankind must take the universal initiative in effecting the design revolution.

You, of this world conference, Vision 65, at Southern Illinois University, are experts on how to communicate. This is the message that you must communicate to the world society in time to accomplish Utopia before Oblivion occurs.