#### WIENER / WEINER

# THE Human Use of Human Beings

### CYBERNETICS AND SOCIETY

## Norbert Wiener

PROFESSOR OF MATHEMATICS AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY



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STATEMENTS

LAWRENCE WEINER

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#### THE MECHANISM OF LANGUAGE

I HAVE ALREADY POINTED OUT how language is perhaps the most distinctive feature of man as compared with the lower animals. In this chapter, I wish to show nevertheless that language is not an exclusive attribute of man, but is one which he may share to a certain degree with the machines he has constructed. I wish to show that man's preoccupation with language most certainly represents a possibility which is built into him, and which is not built into his nearest relatives, the great apes. Nevertheless, I shall show that it is built in only as a possibility which must be made good by learning.

We ordinarily think of communication and of language as being directed from person to person. However, it is quite possible for a person to talk to a machine, a machine to a person, and a machine to a machine. In the wilder stretches of our own West and of Northern Canada, there are many possible power sites remote from any settlement where the workers can live, and too small to justify the foundation of new settlements on their own account, though not so small that the power systems are able to neglect them. It is thus desirable to operate these stations in a way that does not involve a resident staff, and in fact leaves the stations unattended for months between the consecutive rounds of a supervising engineer.

To accomplish this, two things are necessary. One of these is the introduction of automatic machinery; making it

General Statements

A field cratered by structured simul taneous TNT explosions

impossible to switch a generator on to a bus-bar or connecting member until it has come into the right frequency, voltage, and phase; and providing in a similar manner against other disastrous electrical, mechanical, and hydraulic contingencies. This type of operation would be enough if the daily cycle of the station were unbroken and unalterable.

This, however, is not the case. The load on a generating system depends on many variable factors. Among these are the industrial demand; emergencies which may remove a part of the system from operation; and even passing clouds, which may make tens of thousands of offices and homes turn on their electric lights in the middle of the day. It follows that the automatic stations, as well as those operated by a working crew, must be within the constant reach of the load dispatcher. He must therefore be able to give orders to his machines; and this he does by sending appropriately coded signals to the power station, either over a special line designed for the purpose, or over existing telegraph or telephone lines, or over a carrier system making use of the power lines themselves. On the other hand, before the load dispatcher can give his orders intelligently, he must be acquainted with the state of affairs at the generating station. In particular, he must know whether the orders he has given have been executed, or have been held up through some failure in the equipment. Thus the machines in the generating station must be able to send return messages to the load dispatcher. There is a language emanating from man and directed toward the machine, and there is a language emanating from the machine and directed toward man.

It may seem curious to the reader that we admit machines to the field of language and yet almost totally deny language to the ants. Nevertheless, in constructing machines, it is often very important for us to extend to them certain human attributes which are not found among the lower members of the animal community. If the reader wishes to conceive this as a mere extension of our personality as human beings, he is welcome to do so; but he should be cautioned that the new machines will not stop working merely because we have discontinued to give them human support.

The language directed toward the machine actually consists of more than a single step. From the point of view of the line engineer alone, the code transmitted along the line is complete in itself. To this message we may apply all the notions of cybernetics, or the theory of messages. We may evaluate the amount of information it carries by determining its probability in the ensemble of all possible messages, and then taking the negative logarithm of this probability, in accordance with the theory expounded in Chapter I. However, this represents not the information actually carried by the line, but the maximum amount it might carry, if it were to lead into proper terminal equipment. The amount of information carried with actual terminal equipment depends on the ability of the latter to transmit or to employ the information received.

We are thus led to a new conception of the way in which the generating station receives the orders. Its actual performance of opening and closing switches, of pulling generators into phase, of controlling the flow of water in sluices, and of turning the turbines on or off, may be regarded as a language in itself, with a system of probabilities of behavior given by its own history. Within this frame every possible sequence of orders has its own probability, and hence carries its own amount of information.

It is, of course, possible that the relation between the line and the terminal machine is so perfect that the amount of information contained in a message, from the point of view of the carrying capacity of the line, and the amount of information of the fulfilled orders, measured from the point of

A removal of an amount of earth from the ground The intrusion into this hole of a st andard processed material

One sheet of plywood secured to the floor or wall

view of the operation of the machine, will be both identical with the amount of information transmitted over the compound system consisting of the line followed by the machine. In general, however, there will be a stage of translation between the line and the machine; and in this stage, information may be lost, though it never can be gained. Indeed, the process of transmitting information may involve several consecutive stages of transmission following one another in addition to the final or effective stage; and between any two of these there will be an act of translation, capable of dissipating information. This fact, that information may be dissipated but not gained, is the cybernetic form of the second law of thermodynamics.

Up to this point in this chapter we have been discussing communication systems terminating in machines. In a certain sense, all communication systems terminate in machines, but the ordinary communication systems of language terminate in the rather special sort of machine known as a human being. The human being as a terminal machine has a communication network which may be considered at three distinct levels. For ordinary spoken language, the first human level consists of the ear, and of that part of the cerebral mechanism which is in a permanent and rigid connection with the inner ear. This apparatus, when joined onto the apparatus of sound vibrations in the air, or their equivalent in electric circuits, represents the machine concerned with what is called the *phonetic* aspect of language.

The phonetic aspect of language is that which is concerned with sound and the *semantic* aspect of language is that which is concerned with meaning. For example, the difficulties of translating between German and English are due to the lack of precise correspondence between the meanings of words in one tongue and another, and are semantic. On the other hand, it has been shown that one can get a remarkable semblance of a language like English by taking a sequence of words, or pairs of words, or triads of words, according to the statistical frequency with which they occur in the language. The gibberish which one thus obtains has a remarkably persuasive similarity to good English. This meaningless simulacrum of intelligent speech is practically equivalent to significant language from the phonetic point of view, although it is semantically balderdash. The English of an intelligent foreigner whose pronunciation contains the mark of the country of his birth, or who speaks literary English, is semantically good and phonetically bad. The average synthetic after-dinner speech is phonetically good and semantically bad.

To go back to the human communication apparatus, it is possible but difficult to determine the characteristics of this phonetic machine, and therefore also possible but difficult to determine what is phonetically significant information, and to measure it. It is clear, for example, that the ear and the brain have an effective frequency cut-off preventing the reception of some high frequencies which can penetrate the ear and can be transmitted by the telephone. In other words, these high frequencies, whatever information they may give an appropriate receptor, do not carry any significant amount of information for the ear.

When language is received through the eye, there is a similar visual stage. I do not know that the English language has invented any word which, in a visual language like that of Chinese writing, will correspond to phonetics. However, this stage exists, and is always confused with the phonetic stage by those Chinese scholars who have not reached a European degree of sophistication concerning the rôle of the eye and the ear in European languages and in their own speech.

When speech or writing have gone through the phonetic

One regular rectangular object place d across an international boundary a llowed to rest then turned to and tu rned upon to intrude the portion of one country into the other

A removal to the lathing or support wall of plaster or wall board from a wall stage of reception or its equivalent, they still have to give rise to the notions and the abstractions which we take effectively to constitute significant speech or meaning. This stage of reception, when combined with its phonetic or visual preliminary, constitutes the *semantic* stage.

Semantic reception is associated with great use of memory, and with its consequent long delays. The types of abstractions belonging to the important semantic stage are not merely those associated with built-in permanent subassemblies of neurons in the brain, such as those which must play a large rôle in the perception of geometrical form; but with abstraction detector-apparatus consisting of parts of the *internuncial pool* which have been temporarily assembled for the purpose: that is, of sets of neurons which are available for larger assemblies, but which are not permanently locked into them.

Besides the highly organized and permanent assemblies in the brain that undoubtedly exist, and are found in those parts of the brain associated with the organs of special sense, as well as in other places, there are particular switchings and connections which seem to have been formed temporarily for special purposes, such as learned reflexes and the like. In order to form such particular switchings, it must be possible to assemble sequences of neurons available for the purpose and not already in use. This question of assembling concerns, of course, the synaptic thresholds of the sequence of neurons assembled. Since neurons exist which can either be within or outside of such temporary assemblies, it is desirable to have a special name for them. As I have already indicated, I consider that they correspond rather closely to what the neurophysiologists have known as internuncial pools.

This is at least a reasonable theory of their behavior. The

semantic receiving apparatus neither receives nor translates the language word by word, but idea by idea, and often still more generally. In a certain sense, it is in a position to call on the whole of past experience in its transformations, and these long-time carry-overs are not a trivial part of its work.

There is a third level of communication, which represents a translation partly from the semantic level and partly from the earlier phonetic level. This is the translation of the experiences of the individual, whether conscious or unconscious, into the sort of actions which may be observed externally. We may call this the behavior level of language. In the lower animals, it is the only level of language to which we have any full access beyond the phonetic input. Actually this is true in the case of every human being other than the particular person to whom this passage is addressed in each particular case; in the sense that that person can only have access to the internal thoughts of another person through the actions of the latter. These actions consist of two parts: namely, direct gross actions, of the sort which we also observe in a lower animal; and in the coded and symbolic system of actions which we know as spoken or written language.

It is theoretically not impossible to develop the statistics of the semantic and behavior languages to such a level that we may get a fair measure of the amount of information in each system. At any rate, we can show by general considerations that phonetic language contains less over-all information when compared with the input, or at any rate not more than the transmission system leading to the ear; and that both semantic and behavior language contain less still. This fact again is a form of the second law of thermodynamics, and is only true if at each stage we regard the

One standard dye marker thrown into the sea

A piece of masonite painted allowed to dry Sanded for a certain time elapsure w ith a standard flat finishing sander And secured to the wall or floor information transmitted as the maximum information that could be transmitted with an appropriately coded receiving system.

Let me now call the attention of the reader to something which he may not consider a problem at all – namely, the reason that chimpanzees do not talk. The behavior of the chimpanzees has for a long time been a puzzle to those psychologists who have concerned themselves with these interesting beasts. The young chimpanzee is extraordinarily like a child, and clearly his equal or perhaps even his superior in intellectual matters. The animal psychologists have not been able to keep from wondering why a chimpanzee brought up in a human family and subject to the impact of human speech until an age of one or two, does not accept language as a mode of expression, and itself burst into baby talk.

Fortunately, or unfortunately as the case may be, most chimpanzees, in fact all that have as yet been observed, persist in being good chimpanzees, and do not become quasi-human morons or idiots. I nevertheless think that the average animal psychologist is rather longingly hoping for the individual chimpanzee who will disgrace his simian ancestry by adhering to more human modes of conduct. It is not a question of sheer bulk of intelligence, for there are human animals whose brains would shame a chimpanzee. It just does not belong to the nature of the beast to speak, or to want to speak.

Thus, speech is such a peculiarly human activity that it is not even approached by man's closest relatives and his most active imitators. The few sounds emitted by chimpanzees have, it is true, a great deal of emotional content, but they have not the finesse of that clear and repeated accuracy of organization needed to make them into a code much more accurate than the yowlings of a cat. Moreover (and this seems to differentiate them from human speech), at times they belong to the chimpanzee as an unlearned inborn manifestation, rather than as the learned behavior of a member of a given social community.

This fact of speech, that speech in general belongs to man as man, but that a particular form of speech belongs to man as a member of a particular social community, is most remarkable. In the first place, taking the whole wide range of man as we know him today, it is a safe statement that there is no community of individuals, not mutilated by an auditory or a mental defect, which does not have its own mode of speech. In the second place, all modes of speech are learned, and notwithstanding the attempts of the nineteenth century to formulate a genetic evolutionistic theory of languages, there is not the slightest general reason to postulate any single native form of speech from which all the present forms are originated. It is quite clear that if left alone, babies will make attempts at speech. These attempts, however, show their own inclinations to utter something, and do not follow any existing form of language. It is almost equally clear that if a community of children were left out of con-tact with the language of their seniors through the critical speech-forming years, they would emerge with something, which crude as it might be, would be unmistakably a language.

Why is it then that chimpanzees cannot be forced to talk, and that human children cannot be forced not to? Why is it that the general tendencies to speak and the general visual and psychological aspects of language are so uniform over large groups of people, while the particular linguistic manifestation of these aspects is so multiformly varied? At least partial understanding of these matters is essential to any comprehension of the language-based community. We merely state the fundamental facts by saying that in man,

One sheet of transparent plastic sec ured to the floor or wall

A rectangular canvass and stretcher support with a rectangular removal f rom one of the four corners sprayed with paint for a time elapsure unlike the apes, the impulse to use some sort of language is overwhelming; but that the particular language used is a matter which has to be learned in each special case. It apparently is built into the brain itself, that we are to have a preoccupation with codes and with the sounds of speech, and that the preoccupation with codes can be extended from those dealing with speech to those, like writing and the quipu, which concern themselves with visual stimuli. However, there is not one fragment of these codes which is born into us as a pre-established ritual, like the courting dances of many of the birds, or the system by which ants recognize and exclude intruders into the nest. The gift of speech does not go back to a universal Adamite language disrupted in the Tower of Babel. It is strictly a psychological impulse, and is not a gift of speech, but a gift of the power of speech.

In other words, the block preventing young chimpanzees from learning to talk is a block which concerns the semantic and not the phonetic stage of language. The chimpanzee has simply no built-in mechanism which leads it to translate the sounds that it hears into the basis for its own ideas or into a complex mode of behavior. Of the first of these statements we cannot be sure because we have no direct way of observing it. The second is simply a noticeable empirical fact. It may have its limitations, but that there is such a built-in mechanism in man is perfectly clear.

In this book, we have already emphasized man's extraordinary ability to learn as a distinguishing characteristic of the race, which makes social life a phenomenon of an entirely different nature from the apparent analogous social life among the bees and ants and other social insects. As I have just said, man's use of language is entirely dependent on his ability to learn. The evidence concerning children who have been deprived of the opportunity of contact with their own race over the years normally critical in the ordinary acquisition of language, is perhaps not completely unambiguous. The "Wolf Child" stories, which have led to Kipling's imaginative *Jungle Books*, with their public-school bears and Sandhurst wolves, are almost as little to be relied on in their original stark squalidity as in the Jungle Book idealizations. However, what evidence there is goes to show that there is a critical period during which speech is most readily learned; and that if this period is passed over without contact with one's fellow human beings, of whatever sort they may be, the learning of language becomes limited, slow, and highly imperfect.

This is probably true of most other abilities which we consider to be natural skills. If a child does not walk until it is three or four years old, it may have lost all the desire to walk. Ordinary locomotion may become a task greater than that of the driving of a car for the normal adult. If a person has been blind from childhood, and the blindness has been resolved by a cataract operation or the implantation of a transparent corneal section, the vision that ensues will, for a time, certainly bring nothing but confusion to those activities which have normally been carried out in blindness. This vision may never be more than a carefully learned new attainment of doubtful value. Now, we may fairly take it that the whole of human social life in its normal manifestations centers about speech, and that if speech is not learned at the proper time, the whole social aspect of the individual will be aborted.

To sum up, the human interest in language seems to be an innate interest in coding and decoding, and this seems to be as nearly specifically human as any interest can be. Speech is the greatest interest and most distinctive achievement of man.

Common steel nails driven into the f loor at points designated at time of installation

An amount of paint poured directly u pon the floor and allowed to dry

#### THE HISTORY OF LANGUAGE

THE REALIZATION of the mystery of speech has belonged to man since very early times. The riddle of the sphinx is a primitive form of wisdom. Indeed, the whole notion of the riddle is derived in the English language from the notion "to rede," or to puzzle out. The word "rede" is cognate with the other word "read," in its usual sense. Among many primitive people writing and sorcery are not far apart. The respect for writing goes so far in some parts of China that people are loath to throw away scraps of old newspapers and useless fragments of books.

Close to all these manifestations is the phenomenon of "name magic" in which members of certain cultures go from birth to death under names that are not properly their own, in order that they may not give a sorcerer the advantage of knowing their true names. Most familiar to us of these cases is that of the name of Jehovah of the Jews, in which the vowels are taken over from that other name of God, "Adonai," so that the Name of Power may not be blasphemed by being pronounced in profane mouths.

From the magic of names it is but a step to a deeper and more scientific interest in language. As an interest in textual criticism in the authenticity of oral traditions and of written texts it goes back to the ancients of all civilizations. A holy text must be kept pure. When there are divergent readings they must be resolved by some critical commentator. Accordingly, the Bible of the Christians and the Jews, the sacred books of the Persians and the Hindus, the Buddhist scriptures, the writings of Confucius, all have their early commentators. What has been learned for the maintenance of true religion has been carried out as a literary discipline, and textual criticism is one of the oldest of intellectual studies.

For a large part of the last century philological history was reduced to a series of dogmas which at times shows a surprising ignorance of the nature of language. The model of the Darwinian evolutionism of the times was taken too seriously and too uncritically. As this whole subject depends in the most intimate manner on our views of the nature of communication, I shall comment on it at a certain length.

The early speculations that Hebrew was the language of man in Paradise, and that the confusion of language originated at the building of the Tower of Babel, need not interest us here as anything more than primitive precursors of scientific thought. However, the later developments of philological thought have retained for a long time an almost equal naïveness. That languages are related, and that they undergo progressive changes leading in the end into totally different languages, were observations which could not long remain unnoticed by the keen philological minds of the Renaissance. A book such as Ducange's Glossarium Mediae atque Infimae Latinitatis could not exist without making it perfectly clear that the roots of the Romance languages are not only in Latin, but in vulgar Latin. There must have been many learned rabbis who were well aware of the resemblance of Hebrew, Arabic, and Syriac. When, under the advice of the much maligned Warren Hastings, the East India Company founded its School of Oriental Studies at Fort William, it was no longer possible to ignore that Greek and Latin on the one hand, and Sanskrit on the other, were cut out of the same cloth. At the beginning of the last cen-

A series of stakes set in the ground at regular intervals to form a recta ngle

Twine strung from stake to stake to demark a grid

Specific Statements

tury the work of the brothers Grimm and of the Dane, Rask, showed not only that the Teutonic languages came within the orbit of this so-called Indo-European group, but went further to make clear the linguistic relations of these languages to one another, and to their distant common parent, whatever that might be.

Thus evolutionism in language antedates the refined Darwinian evolutionism in biology. Valid as this evolutionism is, it very soon began to outdo biological evolutionism in places where the latter was not applicable. It assumed, that is, that the languages were independent, quasi-biological entities, with their developments modified entirely by internal forces and needs. In fact, they are epiphenomena of human intercourse, subject to all the social forces due to changes in the pattern of that intercourse.

In the face of the existence of *Mischsprachen*, of languages such as Lingua Franca, Swahili, Yiddish, Chinook Jargon, and even to a considerable extent English, there has been an attempt to trace each language to a single legitimate ancestor, and to treat the other participants in its origin as nothing more than godparents of the newborn child. There has been a distinction between legitimate phonetic formations showing the accepted laws, and such regrettable accidents as nonce words, popular etymologies, and slang. On the grammatical side, the original attempt to force all languages of any origin whatsoever into the strait-jacket manufactured for Latin and Greek has been succeeded by an almost as rigorous attempt to form for each of them its own paradigms of construction.

It is scarcely until the recent work of Otto Jespersen that any considerable group of philologists have had objectivity enough to make of their science a representation of language as it is actually spoken and written, rather than a copybook attempt to teach the Eskimos how to speak Eskimo, and the Chinese how to write Chinese. The effects of misplaced grammatical purism are to be seen well outside of the schools. First among these, perhaps, is the way in which the Latin language, like the earlier generation of classical gods, has been slain by its own children.

During the Middle Ages Latin of a varying quality, the best of it quite acceptable to anyone but a pedant, remained the universal language of the clergy and of all learned men throughout Western Europe, even as Arabic has remained in the Moslem world down to the present day. This continued prestige of Latin was made possible by the willingness of writers and speakers of the language either to borrow from other languages, or to construct within the frame of Latin itself, all that was necessary for the discussion of the live philosophical problems of the age. The Latin of Saint Thomas is not the Latin of a Cicero, but Cicero would have been unable to discuss Thomistic ideas in the Ciceronian Latin.

It may be thought that the rise of the vulgar languages of Europe must necessarily have marked the end of the function of Latin. This is not so. In India, notwithstanding the growth of the neo-Sanskritic languages, Sanskrit has shown a remarkable vitality lasting down to the present day. The Moslem world, as I have said, is united by a tradition of classical Arabic, even though the majority of Moslems are not Arabic speakers and the spoken Arabic of the present day has divided itself into a number of very different dialects. It is quite possible for a language which is no longer the language of vulgar communication to remain the language of scholarship for generations and even for centuries. Modern Hebrew has survived for two thousand years the lack of use of Hebrew in the time of Christ, and indeed has

Two sheets of standard 8-1/2" X 11" typ ing paper bonded at equal distance f rom on either side of the white line of the Los Angeles Freeway The utilization of a broken double o r otherwise line in no way alters th e intent

Three minutes of forty pound pressur e spray of white highway paint upon a well tended lawn The lawn is allowed to grow and not tended until the grass is free of al I vestiges of white highway paint come back as a modern language of daily life. In what I am discussing now, I am referring only to the limited use of Latin as a language of learned men.

With the coming of the Renaissance, the artistic standards of the Latinists became higher, and there was more and more a tendency to throw out all post-classical neologisms. In the hands of the great Italian scholars of the Renaissance, this reformed Latin could be, and often was, a work of art; but the training necessary to wield such a delicate and refined tool was beyond that which would be incidental to the training of the scientist, whose main work must always concern itself with content rather than with perfection of form. The result was that the people who taught Latin and the people who used Latin became ever more widely separated classes, until the teachers completely eschewed the problem of teaching their disciples anything but the most polished and unusable Ciceronian speech. In this vacuum they ultimately eliminated any function for themselves other than that of specialists; and as the specialty of Latinism thus came to be less and less in general demand, they abolished their own function. For this sin of pride, we now have to pay in the absence of an adequate international language far superior to the artificial ones such as Esperanto, and well suited for the demands of the present day.

Alas, the attitudes of the classicists are often beyond the understanding of the intelligent layman! I recently had the privilege of hearing a commencement address from a classicist who bewailed the increased centrifugal force of modern learning, which drives the natural scientist, the social scientist, and the literary man ever farther from one another. He put it into the form of an imaginary trip which he took through a modern university, as the guide and mentor to a reincarnated Aristotle. His talk began by presenting in the pillory bits of technical jargon from each modern intellectual field, which he supposed himself to have presented to Aristotle as horrible examples. May I remark that all we possess of Aristotle is what amounts to the school notebooks of his disciples, written in one of the most crabbed technical jargons in the history of the world, and totally unintelligible to any contemporary Greek who had not been through the discipline of the Lycaeum? That this jargon has been sanctified by history, so that it has become itself an object of classical education, is not relevant; for this happened after Aristotle, not contemporaneously with him. The important thing is that the Greek language of the time of Aristotle was ready to compromise with the technical jargon of a brilliant scholar, while even the English of his learned and reverend successors is not willing to compromise with the similar needs of modern speech.

With these admonitory words, let us return to the modern point of view on language, which assimilates the operation of linguistic translation and the related operations of the interpretation of language by ear and by brain to the performance and the coupling of non-human communication networks. It will be seen that this is really in accordance with the modern and once heretical views of Jespersen and his school. Language is no longer something that is primarily normative. It has become factual. The question is not what code should we use, but what code do we use. It is quite true that in the finer study of language, normative questions do indeed come into play, and are very delicate. Nevertheless, they represent the last fine flower of the communication problem, and not its most fundamental stages.

We have thus established the basis in man for the simplest element of his communication: namely, the communication of man with man by the immediate use of language, when two men are face to face with one another. The inventions of the telephone, the telegraph, and other similar means of

One sheet of clear plexiglass of arb ltrary size and thickness secured at the four corners and exact center by screws to the floor

One square limestone slab of arbitra ry thickness One sheet of brown wrapping paper bo nded even with the edges to the top surface of the limestone communication have shown that this capacity is not intrinsically restricted to the immediate presence of the individual, for we have many means to carry this tool of communication to the ends of the earth.

Among primitive groups the size of the community for an effective communal life is restricted by the difficulty of transmitting language. For many millennia, this difficulty was enough to reduce the optimum size of the State to something of the order of a few million people, and generally fewer. It will be noted that the great empires which transcended this limited size were held together by improved means of communication. The heart of the Persian Émpire was the Royal Road and the relay of messengers who con-veyed the Royal Word along it. The great empire of Rome was only possible because of the Roman progress in roadbuilding. These roads served to carry not only the legions, but the written authority of the Emperor as well. With the airplane and the radio of today, the word of the rulers extends to the ends of the earth, and very many of the reasons which previously prevented the existence of a World State have been abrogated. It is even possible to maintain that modern communication, which forces us to adjudicate the international claims of different broadcasting systems and different airplane nets, has made the World State inevitable.

#### THE INDIVIDUAL AS THE WORD

THE EARLIER ACCOUNTS of individuality were associated with some sort of identity of matter, whether of the material substance of the animal or the spiritual substance of the human soul. We are forced nowadays to recognize individuality as something which has to do with continuity of pattern, and consequently with something that shares the nature of communication.

Some forty-five years ago, Kipling wrote a most remarkable little story. This was the time when the flights of the Wright brothers had become familiar to the world, but before aviation was an everyday matter. He called this story "With the Night Mail," and it purports to be an account of the world when aviation should have become a matter of course and the Atlantic a lake to be crossed in one night. He supposed that transportation as facilitated by the airplane had so united the world that war had become obsolete, and that all the world's really important affairs were in the hands of an Aerial Board of Control, whose primary responsibility extended to air traffic, while its secondary responsibility extended to "all that that implies." In this way, he imagined that the various local authorities had gradually been compelled to drop their rights, or had allowed their local rights to lapse; and that the central authority of the Aerial Board of Control had taken these responsibilities over. It is rather a Fascist picture which Kipling gives us, and this is understandable in view of his intellectual pre-

One hole in the ground approximately one foot by one foot by one foot One gallon water base white paint po ured into this hole

Four strips of linoleum of arbitrary width cemented to the floor edge to edge with the forth strip one width shorter than the preceding three suppositions. It is not a necessary condition of the situation which he envisages. His millennium is the millennium of a British colonel back from India. Moreover, with his love for the gadget as a collection of wheels that rotate and make a noise, he has emphasized the extended physical transportation of man, rather than the transportation of language and ideas. He does not seem to realize that where a man's word goes, and where his power of perception goes, to that point his control and in a sense his physical existence is extended. To see the whole world and to give commands to the whole world is almost the same thing as to be everywhere. Nevertheless, with these natural reservations, Kipling has the poet's insight, and the things he has foreseen are rapidly coming to pass.

To see the greater importance of communication as compared with transportation, let us suppose that we have an architect in Europe supervising the construction of a building in the United States. I am assuming, of course, an adequate working staff of constructors, clerks of the works, etc., on the site of the construction. Under these conditions, even without transmitting or receiving any material commodities, the architect may take an active part in the construction of the building. Let him draw up his plans and specifications as usual. Even at present, there is no reason why the working copies of these plans and specifications must be transmitted to the construction site on the same paper on which they have been drawn up in the architect's drafting-room. The modern Ultrafax gives a means by which a facsimile of all the documents concerned may be transmitted in a fraction of a second, and the received copies are quite as good working plans as the originals. The architect may be kept au fait with the progress of the work by photographic records taken every day or several times a day;

and these may be forwarded back to him by Ultrafax. Any remarks or advice he cares to give his representative on the job may be transmitted by telephone, Ultrafax, or teletypewriter. In short, the bodily transmission of the architect and his documents may be replaced very effectively by the message-transmission of communications which do not entail the moving of a particle of matter from one end of the line to the other. We thus have two types of communication: namely, a material transport, and a transport of information alone. At present it is possible for a person to go from one place to another by material transportation, and not as a message. However, even now the transportation of messages serves to forward an extension of his senses and his capabilities of action from one end of the world to another. Is this distinction between material transportation and message transportation absolutely permanent and unbridgeable?

To pose this question raises very fundamental issues concerning the nature of human individuality. The problem of the nature of human individuality and of the barrier which separates one personality from another is as old as history. The Christian religion and its Mediterranean antecedents have embodied it in the notion of *soul*. The individual possesses a soul, so say the Christians, which has come into being by the act of conception, but which will continue in existence for all eternity, either among the Blessed or among the Damned, or in one of the little intermediate lacunae of Limbo which the Christian faith allows.

The Buddhists follow a tradition which agrees with the Christian tradition in giving to the soul a continuity after death, but this continuity is in the body of another animal or another human being, rather than in some Heaven or Hell. There are indeed Buddhist Heavens and Hells, although the stay of the individual there is generally temporary. In the

One aerosol can of enamel sprayed to conclusion directly upon the floor

One standard interior grade sheet fo ur foot by eight foot by three quart er inch plywood secured at the four corners and exact center by screws t o the wall most final Heaven of the Buddhists, however, the state of Nirvana, the soul loses its identity and is absorbed into the Great Soul of the World.

These views have been without the benefit of the influence of science. The most interesting early scientific account of the continuity of the soul is that of Leibniz. Leibniz conceived the soul as belonging to a larger class of permanent spiritual substances which he called *monads*. These monads spend their whole existence from the creation on in the act of perceiving one another; although some perceive with a great clarity and distinctness, and others in a blurred and confused manner. This perception does not however represent any true interaction of the monads. The monads "have no windows," and have been wound up by God at the creation of the world so that they shall keep in time with one another through all eternity. They are indestructible.

Behind Leibniz's philosophical views of the monads there lie some very interesting biological speculations. It was in Leibniz's time that Leeuwenhoek first applied the simple microscope to the study of very minute animals and plants. Among the animals that he saw were spermatozoa. In the mammal, spermatozoa are infinitely easier to find and to see than ova. The human ova are emitted one at a time, and unfertilized uterine ova or very early embryos were until recently rarities in the anatomical collections. Thus the early microscopists were under the very natural temptation to regard the spermatozoon as the only important element in the development of the young, and to ignore entirely the possibility of the as yet unobserved phenomenon of fertilization. Furthermore, their imagination displayed to them in the front segment or head of the spermatozoon a minute foetus, rolled up with head forward. This foetus was supposed to contain in itself spermatozoa which were to develop into the next generation of foetuses and adults, and so on ad infinitum. The female was supposed to be merely the nurse of the spermatozoon.

Of course, from the point of view of the present time, this biology is simply false. The spermatozoon and the ovum are nearly equal participants in the overwhelmingly more important part of heredity. Furthermore, the germ cells of the future generation are only contained in them in *posse*, and not in *esse*. Matter is not infinitely divisible, nor indeed from any absolute standpoint is it very finitely divisible; and the successive diminutions required to form the Leeuwenhoek spermatozoon of a moderately high order would very quickly lead us down beyond electronic levels.

In the present view, as opposed to the Leibnizian view, the continuity of an individual has a very definite beginning in time, but it may even have a termination in time quite apart from the death of the individual. It is well known that the first cell division of the fertilized ovum of a frog leads to two cells, which can be separated under appropriate conditions. If they are so separated, each will grow into a complete frog. This is nothing but the normal phenomenon of identical twinning in a case in which the anatomical accessibility of the embryo is sufficient to permit experimentation. It is exactly what occurs in human identical twins, and is the normal phenomenon in one of the armadillos which bears a set of identical quadruplets at each birth. It is the phenomenon, moreover, which gives rise to double monsters, when the separation of the two parts of the embryo is incomplete.

This problem of twinning may however not appear as important at first sight as it really is, because it does not concern animals or human beings with what may be considered well-developed minds and souls. Not even the problem of the double monster, the imperfectly separated twins, is too serious in this respect. Viable double monsters must

One quart exterior green enamel thro wn on a brick wall

A sheet of brown paper of arbitrary width and length of twice that width with a removal of the same proportio ns glued to the floor always have either a single central nervous system or a well-developed pair of separate brains. The difficulty arises at another level in the problem of split personalities.

A generation ago, Dr. Morton Prince of Harvard gave the case history of a girl, within whose body several better-orworse-developed personalities seemed to succeed one another, and even to a certain extent to coexist. It is the fashion nowadays for the psychiatrists to look down their noses a little bit when Dr. Prince's work is mentioned, and to attribute the phenomenon to hysteria. It is quite possible that the separation of the personalities was never as complete as Prince sometimes appears to have thought it to be, but for all that it was a separation. The word "hysteria" refers to a phenomenon well observed by the doctors, but so little explained that it may be considered but another questionbegging epithet.

One thing at any rate is clear. The physical identity of an individual does not consist in the matter of which it is made. Modern methods of tagging the elements participating in metabolism have shown a much higher turnover than was long thought possible, not only of the body as a whole, but of each and every component part of it. The biological individuality of an organism seems to lie in a certain continuity of process, and in the memory by the organism of the effects of its past development. This appears to hold also of its mental development. From the standpoint of the computing machine, the individuality of a mind lies in the retention of its earlier tapings and memory, and in its continued development along lines already laid out.

Under these conditions, just as a computing machine may be used as a pattern on which to tape other computing machines, and just as the future development of these two machines will continue parallel except for future changes in taping and experience, so too, there is no inconsistency in a living individual forking or divaricating into two individuals sharing the same past, but growing more and more different. This is what happens with identical twins; but there is no reason why it could not happen with what we call the mind, without a similar split of the body. To use computingmachine language again, at some stage a machine which was previously assembled in an all-over manner may find its connections divided into partial assemblies with a higher or lower degree of independence. This would be the best explanation of the cases of Dr. Morton Prince.

Moreover, it is conceivable that two large machines which had previously not been coupled may become coupled so as to work from that stage on as a single machine. Indeed this occurs on the level of the union of the germ cells, although perhaps not on what we would ordinarily call a purely mental level. The mental identity necessary for the Church's view of the individuality of the soul certainly does not exist in any absolute sense which would be acceptable to the Church.

To recapitulate: the individuality of the body is that of a flame rather than that of a stone, is that of a form rather than that of a bit of substance. This form can be transmitted or be modified and duplicated, although at present we only know how to duplicate it over a short distance. When one cell divides into two, or when one of the genes which carries our corporeal and mental birthright is split in order to make ready for a reduction division of a germ cell, we have a separation in matter which is conditioned by the power of a pattern of living tissue to duplicate itself. Since this is so, there is no fundamental absolute line between the types of transmission which we can use for sending a telegram from country to country and the types of transmission which at least are theoretically possible for a living organism such as a human being.

A 2" wide 1" deep trench cut across a standard one car driveway

One 106" X 16" slab of "Dow HD 300" styrofoam sunk flush with the ground

Let us then admit that the old idea of the child, that in addition to traveling by train or airplane, one might conceivably travel by telegraph, is not intrinsically absurd, far as it may be from realization. The difficulties are, of course, enormous. It is possible to evaluate something like the order of the significant information covered by all the genes in a germ cell, and answer the question of the amount of heredi-tary information, as compared with learned information, that a human being possesses. The smallest order which makes any sense whatever is that of the amount of information contained in a complete set of the Encyclopaedia Britannica. If we try to compare, for example, the number of asymmetric carbon atoms <sup>1</sup> in all the molecules of a germ cell with the number of dots and dashes needed to code the Encyclopaedia Britannica, we find that they constitute an even more enormous message; and this is still more impressive when we realize what the conditions for telegraphic transmission of such a message must be. Any scanning of the human organism must be a probe going through all parts, and must have a greater or less tendency to destroy the tissue on its way. To hold an organism stable while part of it is being slowly destroyed, with the intention of re-creating it out of other material elsewhere, involves a lower-ing of its degree of activity, which in most cases we should consider to prevent life in the tissue.

In other words, the fact that we cannot telegraph the pattern of a man from one place to another is probably due to technical difficulties, and in particular, to the difficulty of keeping an organism in being during such a radical reconstruction. It is not due to any impossibility of the idea. As to the problem of the radical reconstruction of the living

 $<sup>^1</sup>$  It is perfectly clear that the message is *not* carried by the asymmetric carbon atoms; but they represent the sort of mark that can be conceived to carry a message.

organism, it would be hard to find any such reconstruction much more radical than the actual one of a butterfly during its period as a pupa.

I have stated these things, not because I want to write a science fiction story concerning itself with the possibility of telegraphing a man, but because it may help us understand that the fundamental idea of communication is that of the transmission of messages, and that the bodily transmission of matter and messages is only one conceivable way of attaining that end. It will be well to reconsider Kipling's test of the importance of traffic in the modern world from the point of view of a traffic which is overwhelmingly not so much the transmission of human bodies as the transmission of human information.