Alfred Korzybski Memorial Lecture

PANDORA'S BOX

WHY AND HOW TO COMMUNICATE 10,000 YEARS INTO THE FUTURE*

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Preamble

Shortly after the inauguration of Ronald Reagan as the 40th President of the United States, my services were engaged by the Bechtel Group, Inc., as a consultant to the Human Interference Task Force, assigned responsibility for "reducing the likelihood of future human activities that could affect geological high-level waste repositories." The specific assignment of this Task Force was to prepare a report on this topic for submission to the U.S. Nuclear Regulatory Commission, via the U.S. Department of Energy. It was prepared under the auspices of the National Waste Terminal Storage Program, which directs both the development and the implementation of the technology required for designing, constructing, licensing, and operating repositories. In September, 1981, the report of our Task Force was duly submitted, but the opinions expressed and positions stated by the members have, as of the Summer, 1982, not yet been endorsed by the Department of Energy. The article that follows constitutes an up-dated version of my own report to the Bechtel Group; although I have, of course, learned a great deal from my collaborators, and have profited from the draft document mentioned, it contains solely my personal views on the specific problem on which I was asked to work: designing a reasonably fail-safe means of communicating information about the repository and its contents, such that the system's effectiveness would be maintained for up to 10,000 years.

The 10,000 years limitation forecast -- roughly equivalent to 300 generations, according to current actuarial tables -- is clearly an arbitrary limit; while the projection is consistent with the Department of Energy's Statement of Position on the Nuclear Regulatory Commission Waste Confidence Rulemaking (DOE/NE-0007, April 15, 1980), and with certain preliminary criteria of the Environmental Protection Agency (40 CFR 191, Working Draft No. 19, 1981), one must nevertheless be mindful that the radioactive half-life of, for example, the metal thorium 232 is 10 billion years, more or less, by contrast with, say, that of Plutonium 214, which is a mere fraction of one second.

The expression "high-level wastes" is defined by the Code of Federal Regulations (Part 50, Appendix F) as "those aqueous wastes resulting from the operation of the first cycle solvent extraction system, or equivalent, in a facility for reprocessing irradiated reactor fuel." In other words, as contrasted with "low-level," at least in the United States, the term is not a measure of radioactive intensities.

Since I submitted my formal report, Fred C. Shapiro's exhaustive study of radioactive wastes, Radwaste (1981) appeared. This is an invaluable source of reliable information on the entire range

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of depressing issues involved in the disposal of radwaste, awesome mountains of which continue to accrete inexorably while our Federal Government and the States of the Union argue over a "permanent solution" for getting rid of these toxic materials.

As I am writing this preamble, to accompany the published version of my report, the New York Times (July 11, 1982, pp. 1 & 17) informs its readership: "In a sealed carbon-steel tank" in West Valley, a community near Buffalo, "encased in concrete walls eight feet below the earth, is 560,000 gallons of poisonous waste, produced by the only commercial nuclear-fuel reprocessing plant ever to operate in the United States. The liquid will be dangerously radioactive for thousands of years; the tank has a life expectancy of 40." The Department of Energy proposed to mix the radioactive waste with glass, and then emplace the 300 or so vitrified logs formed in a metal mold overpacked by some combination of cement, clay, and/or metal that will protect the logs, each about ten feet long and two feet in diameter, from corrosive elements for 1,300 years. Four years ago, it was estimated that the cost of this solidification would be $130 million; the current estimate for doing the job, which is still in the "design" stage, is that it will cost "under $500 million." There are serious questions about whether the glass, now favored as a permanent storage medium, would nevertheless allow some radioactivity to escape into the environment. It is problematic whether the use of borosilicate glass would be secure. According to present plans, the wastes will be stored in salt formations -- precisely where has not yet been decided -- which are supposed to persist for the tens of thousands of years that the waste will be so radioactive that its isolation is desired. On April 27th of this year (1982) the Senate endorsed the Nuclear Waste Policy Act, (S. 1662), which calls for the development of a plan for determining suitable sites to store, bury, and isolate radioactive waste, some containing materials predicted to be lethal for 240,000 years. The House has yet to act on a comparable measure (H.R. 3809). The Department of Energy estimates that the earliest date a final repository could be available will be in the year 2000; some scientists criticize this target as impossible to make. As Marshall (1982:710) has noted: "Even if enacted this year, a bill like this would have to be considered only a hesitant first try at solving the nuclear waste problem. It deals with none of the technical disputes and leaves the highly difficult task of site selection to the bureaucracy."

Finally, it should be mentioned that ocean dumping of radwastes is again under active consideration, in an atmosphere of both concern and controversy (Norman 1982). However, my job was to focus on geological repositories deep beneath the earth's surface, and to ignore, for purposes of this report, marine disposal of waste materials, as well as other options which have variously been put forward.

This paper is concerned neither with engineering nor economic problems -- and not at all with their international dimensions -- but solely with the design of a method to prevent human interference with repositories during the first 10,000 years after their closure.

Introduction

Any viable strategy for radioactive (hazardous) waste disposal, in which the repository would be situated in a crystalline rock mass beneath a blanket of sedimentary rocks whose physical characteristics are well understood, entails the possibility of human intrusion, which must and can be minimized. For any repository situated in a geological medium, all sorts of natural and man-made barriers can be brought into play to act to prevent migration of the wastes, such as:"(i) the waste form and its capsule; (ii) engineered barriers within the repository, such as low-permeability, highly sorptive backfill; and (iii) the migration path back to the biosphere through the ground-water flow system" (Bredehoeft and Maini 1981:296); and others (e.g., Winograd 1981). A "barrier" is commonly defined as a mechanism or medium by which the movement of em-

placed radioactive material is stopped or retarded significantly; for a cautiously sanguine discussion of a combination of relevant geologic technology, a consistent systems approach and the multi-barrier concept, see Klingsberg and Duguid (1982).

The present paper deals with semiotic techniques designed to restrict, if not altogether prevent, access to the material. The objective is to minimize the possibility of future human intrusion at the site; therefore, a disposal strategy needs to be developed that takes cognizance of the soundest knowledge currently available in the field of general Semiotics.

Semiotics is the name of the discipline which brackets the conjoint scientific study of both verbal and averbal systems of communication. It is thus focally relevant to the problems of human interference and message exchanges involving long periods of time, over which spoken and written languages are sure to decay to the point of incomprehensibility, making it necessary to utilize a perspective that goes well beyond linguistics (the formal study of verbal messages), which, traditionally (mainly in the 19th century), has dealt with the relatively brief diachronic past, or (mainly in the 20th century) the synchronic present. Workers in semiotics, or in its narrower branch called linguistics, have very seldom been called upon to make projections into the short-range future, let alone the long-range future, which, in the case at hand, must take into account up to 10,000 years.

It is generally believed that the "social function of communication is the ensuring of continuity in society through access to the experiences and ideas of the past, expressed in [loosely speaking] symbols for transmission across space and through time. This is the 'time-binding' function of social communication" (Neelameghan 1979:103).* Man's time-binding ability arises from his usage of "language, number, gesture, picture and other symbolic forms" (loc. cit.) enabling him to transcend the limitations of inherited characteristics and the seemingly insurmountable barrier of "time." It should be noted, in passing, that an era will come when messages vitally important to the race, affecting its survival, will be transmissible by microsurgical intervention with man's molecular blueprint, but the technology required for this form of temporal communication is far from available as yet. Therefore, in what follows, this theoretical possibility will not be further considered.

Some Basic Principles of Semiotics

*Semiotics,[1] the pivotal branch of the integrated science of communication (cf. Jakobson 1970:33), is concerned with the formulation and encoding of messages by *sources, the transmission of these messages through *channels, the *decoding and *interpretation of these messages by *destinations, and their *signification. The entire transaction, or *semiosis, takes place within a *context to which the system is highly sensitive and which the system, in turn, affects. Any living entity, or its products, can be either message sources or destinations. Humans are unique in being able to process both verbal and averbal messages. Semiosic acts are monitored by *feed mechanisms (Bogart 1980), which can variously function to fine-tune performances. Differences between input and output are due to *noise, which can, however, be counteracted by *redundancy. The process of message interchanges, or semiosis, is held by many to be an indispensable characteristic of all terrestrial life forms. It is this capacity for containing, replicating, and expressing messages, of extracting their significance, that, in fact, distinguishes them more consistently from the nonliving -- except

*First formulated by Alfred Korzybski in Manhood of Humanity: The Science and Art of Human Engineering. New York: E. P. Dutton, 1921. Ed.

[1]Expressions preceded by an asterisk are defined in the "Glossary of Technical Terms."

for human agents, such as robots, that can be programmed to engage in quasi-semiosis -- rather than other traits often cited, such as the ability to reproduce (e.g., mules or neutered cats do act as message sources and destinations, but none can reproduce).

All human messages fall into two distinct categories: *verbal messages and *averbal messages. *Language -- as the array of verbal messages is collectively referred to -- has, so far, been found only in our own species; biologists would thus say that language constitutes a "species-specific" trait. The study of this unique yet "species-universal" attribute of man, his language, is the subject matter of *linguistics, which is one of the most sophisticated, partially formalized branches of semiotics. Man's rich repertoire of averbal messages -- by sharp contrast with his language -- has not comprised a unified field of study, and therefore lacks a positive integrative label. Averbal messages are, by definition, not linguistic. This negative delineation has led to terminological chaos, which is manifoldly compounded when the multifarious message systems employed by the millions of speechless creatures are additionally taken into account.

Averbal messages can be distinguished from one another according to several criteria of semiotic relevance. Let me briefly illustrate this point by going back to a classic discussion found in the Hippocratic writings on medical semiotics, where sēmeion -- from the same root as both *"semiotics" and *"semiology" -- is used to refer to the observable "symptoms" by which a physician identifies a disease ("makes a diagnosis") and forecasts its outcome ("makes a prognosis") (cf. Miller 1979:44). This standpoint of Hippocrates (ca. 460 - ca. 377 B.C.) -- whom historians have sometimes reverentially regarded as "the father and master of all semiotics" -- hinges on an ancient but still widely prevalent distinction drawn between two kinds of messages: "conventional" vs. "natural." *Conventional messages are those whose power to signify is thought to depend on some prior agreement, presumed to have been reached at some temporal juncture and thereafter accepted as a matter of custom -- such as, most importantly, messages cast in spoken or written utterances, but also frequently messages that are embodied in the shape of a parochial gesture, a tradition exercised and understood by one group of persons but not necessarily by their neighbors. The meaning of a conventional message -- whether verbal or not -- is invariably circumscribed to a time and place. So-called *natural messages, on the other hand, have the power to signify the same things at all times and in all places, precisely because their interpretation does not presuppose a familiarity with the conventions of a particular group. For this reason, "natural messages," as here defined, are particularly pertinent to the present responsibility of the Human Interference Task Force.

After describing certain averbal symptoms (sēmeia), Hippocrates does go on to say, in his treatise on Prognostic, that these "prove to have the same significance in Libya, in Delos, and in Scythia." Given the quasi-universality of the class of averbal messages physicians call symptoms, he does not deem it "strange that one should be right in the vast majority of instances, if one learns them well and knows how to estimate and appreciate them properly" (ibid.:45; after Hippocrates' Prognostic xxv).

By contrast, what is sometimes designated as a *"multimessage," i.e., conventional gesture, is one that has a number of totally distinct meanings, the choice of interpretation depending on the time and the place. Thus all Americans are familiar with the raised hand gesture, such that the thumb and forefinger form a circle. This essentially signifies that something is OK. In other countries, however, the same configuration may mean something totally different: for example, in Japan, 'money,' in the South of France, 'zero' or 'worthless'; in many places it may convey an obscene comment or an insult, as it did in Greece more than two thousand years ago; again, in some other areas it may betoken nothing at all (Morris 1977:39-40).

These examples illustrate a single feature by which human averbal messages are distinguishable in terms of their temporal or spatial distribution. Many others can be adduced.

It is convenient to begin a general preliminary consideration of messages where they are assumed to originate. Their inception can be pictured as a box, which I have already designated the *source. A message can now be provisionally defined as a selection out of a *code by a source. The concept of a code will be explained later, but it should immediately be noted that many of the rules of probability governing this selection are unknown.

The source box is nothing more than a formal model used for erecting hypothetical constructs: given a certain input, one must guess, more or less, at what takes place to account for the output. When psychologists speak of "black box," they assume that nothing is known about what is inside the organism or about the functioning, say, of the central nervous system. However, the correlations between input and output may enable certain inferences to be made, not about the mechanism inside the box, but how it works.

In semiotics, it is more accurate to postulate a source box that is not altogether black but falls in a twilight zone between ignorance and knowledge; that is, in some cases, we do know something about its workings, although obviously far from enough. In schematic terms, these complex operations can be divided into two successive processes: an early one so murky as to be hardly more than a vacuous label, and a later one gradually dawning into more or less sharp scientific focus. The first process is referred to as the *formulation (or generation) of the message. A source "formulates" a message, but precisely how any organism does so is not known and will remain enigmatic until the electro-chemical machinery of the human and animal minds, in their immense complexity, is far better understood. Man, it seems reasonable to postulate, follows, by and large, generative rules to create an enormous number of novel messages appropriate to an indefinite variety of contexts, but how he is able to do this is still an utter mystery. Detailed charting of the highly intricate and continuously readapting pathways within the 3 1/2-pound globe of tissue under the skull known as the human brain remains a task for the future. It is conceivable that other animals store in advance separate internal representations for each message produced for use in a limited set of environments, but this is also uncertain. Were we to picture an organic source -- as in Fig. 1, p. 28 -- we would have to darken the leftmost portion to reflect our ignorance; here the box is opaque. If the source were man-made, say, a general purpose computer, we would be able to specify exactly how the mechanical system formulates its messages, since a human programmer has imperatively prescribed the action by a special coding operation: mapping his multidimensional language into some artificial unidimensional language. However, the primary concern here is with tenebrous living primary sources, and only incidentally with translucent inorganic secondary artifacts.[2]

Engineers sometimes speak of two kinds of sources: discrete and continuous. A discrete source produces messages ("letters") selected out of an enumerable set of possibilities ("alphabet"); such a source might produce, for example, written English. A continuous source is one that is not discrete -- say, one that produces spoken English or music.

In the communication disciplines, as throughout the life sciences, it is both

[2]The Human Interference Task Force can be considered as the "source" that is charged with the obligation to collectively formulate the message, or set of messages, for a future destination, i.e., a would-be intruder, or group of intruders, to the repository site.

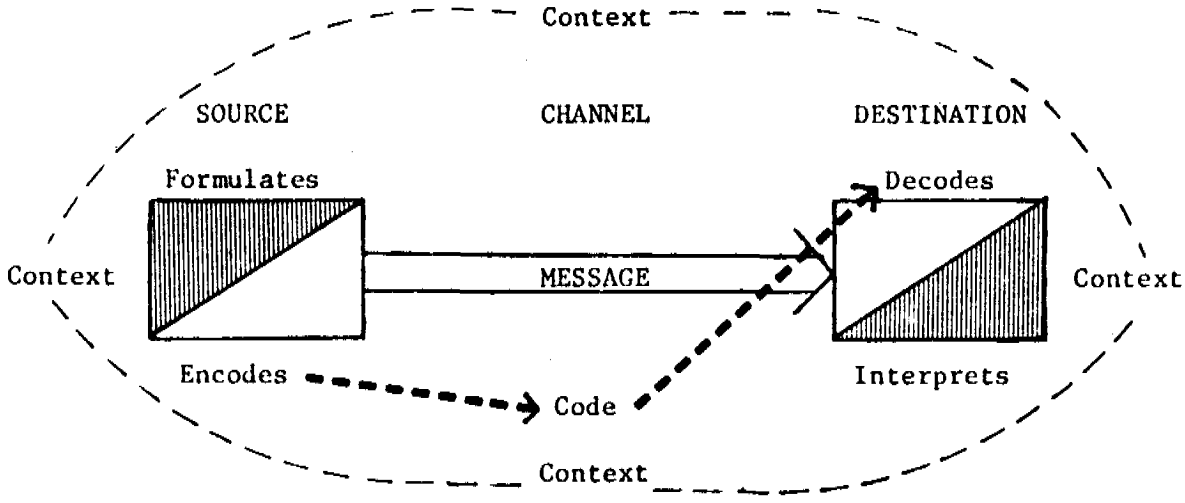

Fig. 1

This diagram can be applied with many variations, to numberless concrete instances of semiosis, as, for instance, in Fig. 2:

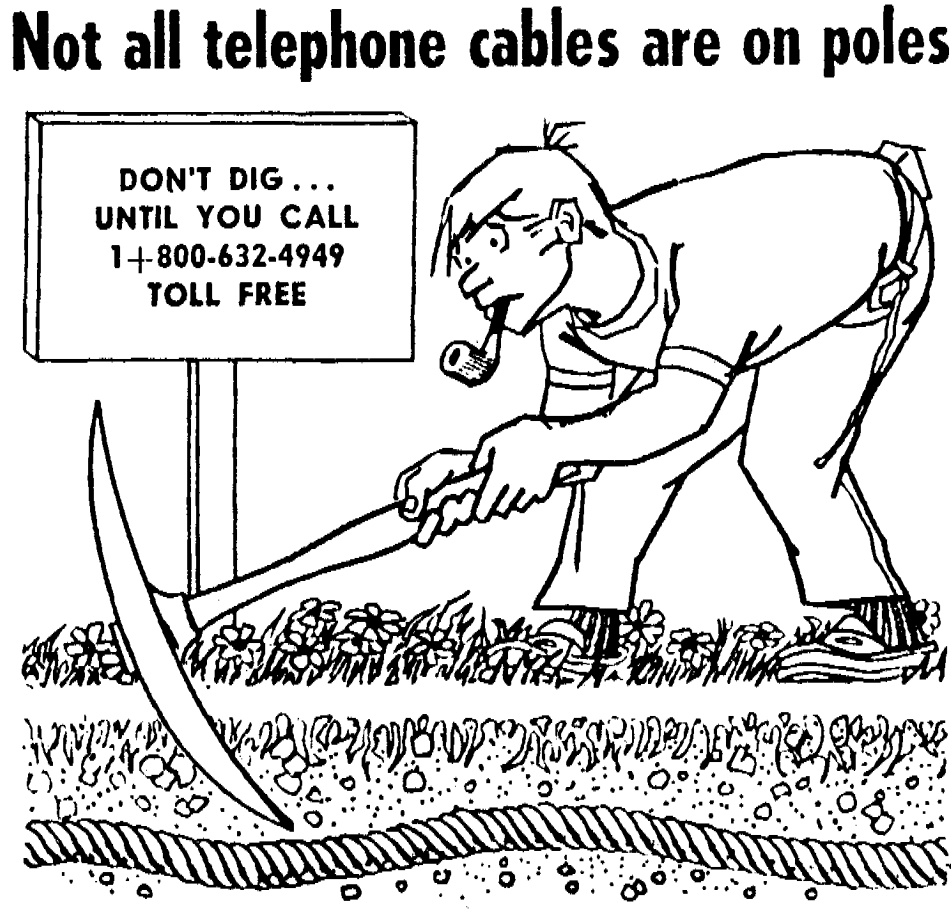

Fig. 2

legitimate and necessary to raise questions teleonomic in aspect. Accordingly, it is now proper to ask: for what purposes do sources formulate messages? The functions of messages are various. They are end-directed in the same objective sense in which all animal behavior has a goal; an animal ingests food to gain materials and energy; its digestive apparatus and enzymes exist and operate as they do in order to promote this goal of survival. Messages embody information biologically or socially important for organisms; they are formulated, among other reasons, in order to be "transferred" to another entity, here named the *destination.

It is convenient to think of the destination as a second box (or operational concept, or a model), the area at which the message flow initiated by the source terminates. Its workings can be segmented into two temporally successive processes, the reverse of formulation: an early one, characteristics of which are more or less understood, and an ultimate one -- usually referred to as the *interpretation of the message -- the manner of which shades off into unfathomed dusk; in this case, the rightmost portion of the diagram (Fig. 1) would have to be blackened.

The source is normally incapable of launching its message in the neuro-electro-chemical shape in which we surmise that it was initially formulated. The reason for this is that there is ordinarily no direct neuro-electro-chemical passageway to the destination; each source is linked with each destination via some sort of medium, or *channel, a passageway through which the two are capable of establishing and sustaining the exchange. An example of a channel is the link postulated between a pair of communicating American Indians, such that one, the source, moves a blanket over a fire, while the other, the destination, observes the resulting message cast, or coded, in smoke (a form of electromagnetic energy). Any form of energy propagation can, in fact, be exploited for purposes of message transformation. The point to remember is that the message-as-formulated -- conceivably, in sinusoidal pattern components -- must next undergo successive transformations while progressing on its journey toward the destination. The transmissions are "handed on" from one relay station to the next, and, before reaching the primary projection area, they need to be rearranged -- filtered and adjusted -- to suit the chosen channel. It is not known, specifically, how one part of the brain communicates with another, how the messages are constructed and stacked in a hierarchy, or how their meanings are "agreed to" (coded). Neurophysiologists surmise that, no matter what a message may correspond to in the external world, internally it is likely to be represented by nerve impulses linked by chemical exchanges, probably functioning synchronously in various regions, which may be closely adjacent to or quite remote from one another in the two-dimensional cortical sheet of higher animals, including man. The transformation from this unconscious parallel processing to an externalized serial string, as in speech, or writing, or gesturing, must be effected by surface organ systems -- in man, e.g., the so-called organs of speech -- and this crucial transduction is called *encoding. It happens at the interface between internal and external message systems, which, in a broad sense, stand in a specular relationship, in a homology of spatial and temporal transition probabilities. When the destination receives the encoded messages another *transduction, followed by a series of further transformations, must be effected before this message can be interpreted; the pivotal reconversion is called *decoding. "Transduction" refers to the neurobiological transmutation from one form of energy to another, such as a photon undergoes when impinging on the vertebrate retina: we know that it entrains impulses in the optic nerve that change rhodopsin (a pigment in the retinal rods of the eyes), through four intermediate chemical steps, from one state to another. A message is said to be "coded" when the source and the destination are "in agreement" on a set of transformation rules used in the exchange. Because of entropy (a measure of disorder in the system; see, e.g., Rifkin 1980, for broad implications of this concept), the message-as-encoded

can never be identical with the message formulated and launched by the source.

The kind of code selected by the source depends crucially on the total sensory equipment at its disposal. It would be abortive for an animal that is dumb -- as the great majority of them are -- to broadcast acoustically coded messages to its fellows that may be deaf. Man's sense organs are capable of registering only a small portion of ambient acoustic stimuli: thus we can normally cope only with frequencies between ~16 and ~22,000 hertz, and are, in this respect, surpassed by the smallest bat, every dog, many rodents, and countless other animals. The range of seeing likewise differs considerably in various animals: man, who is incapable of perceiving ultraviolet, bordering on the X-ray region to about 100 Ångstroms, which is readily distinguishable by the honeybee and other insects, will scarcely encode his messages in the -- to him -- invisible spectrum, which could be decoded by other men only with special enhancing instrumentation. The same is true of infrared, which certain nocturnal mammals, possessing a special organ (the tapetum lucidum), causing reflected night eye-shine, can manage to communicate by "in the dark," as we cannot, save with the aid of recently developed technology. An excursion into the field of sense organs will be necessary to understand the wide variety of codes utilized in the animal world and by man to insure that reciprocal understanding is achieved. Messages are transmitted, through acoustic and the optical channels, as well as through more or less unfamiliar ones; even the best known channels may play a crucial role in communication in ranges beyond the limits of normal (i.e., cognizant) human perception, and thus beyond normal awareness.

The very general diagram (Fig. 1) illustrates the main points shown so far. This model is not to be regarded as a piecemeal assemblage of constituents that can be represented as the sum of the properties of its several parts; on the contrary, the process of semiosis indispensably requires that each constituent be conceived of as functioning in relation to every other.

The source of the message -- i.e., the immediate source -- is the Durham, North Carolina, phone directory for 1981. (See Fig. 2, p. 28.) The ultimate source is the management of General Telephone, upon whose instructions the anonymous draftsman encoded the sketch to suit the text the management wanted to convey to the public, chiefly, that segment likely to engage in shallow digging. The message as a whole consists of a judicious mixture of verbal and averbal elements, which are meant to be mutually reinforcing, or, if the destination is assumed to be illiterate, at least partially significant by virtue of the pictorial element. Note that the design incorporates not only the message intended to be conveyed but also the metamessage ("message about the message") that further information can be and should be obtained, without cost, according to such-and-such a procedure.

A very important component pictured in Fig. 1 is the message <u>context</u>, or setting, in which the entire transaction takes place. The context in which any message is emitted, transmitted, and admitted decisively influences its interpretation, and vice versa: the context of transactions is continually modified by the messages being interpreted; messages, in brief, are always more or less context-sensitive. This much is well known, but just <u>how</u> an organism takes its environment into account remains unclear. The notion of "context" has been employed differently by various investigators, but, broadly speaking, the term refers to the organism's cognizance of conditions and manner of appropriate and effective use of messages. Context includes the whole range of the animal's cognitive systems (i.e., "mind"), messages flowing parallel, as well as the memory of prior messages that have been processed and no doubt the anticipation of future messages expected to be processed. Some semioticians have consigned the study of contexts to a nebulous subdivision of the field called "pragmatics" (complementing "syntactics" and "semantics"; see Morris 1971, Glossary, pp. 359-368; and Cherry 1978, Appendix, pp. 339-343.) In the case

of the phone company's emblem (Fig. 2), whatever context General Telephone's management deemed necessary for potential intruders to know is incorporated, in part, in the English legend printed underneath, and, in part, averbally, in the drawing itself.

Context is often the crucial factor in resolving the significance of a message. Thus messages encoded in the chemicals isovaleric acid and methyl mercaptan are components, respectively, of human body malodor and halitosis. This notwithstanding, the same chemicals and, consequently, the same odors, are responsible for some of the bouquet and flavor of cheese -- contexts account for the difference in interpretation.

The verbal context may subtly yet decisively affect memory, as was shown in a remarkable experiment by Loftus (1980) and Palmer. These two psychologists showed a movie of an automobile accident, and questioned two different groups of "witnesses" about it in two slightly different ways. One group was asked, "How fast were the cars going when they smashed into each other?" The other group was asked, "How fast were the cars going when they hit each other?" A week passed. Then all "witnesses" were asked: "Did you see any broken glass in the accident?" Although there was no broken glass, those who were cued with the verb "smash" were more than twice as likely to erroneously report the presence of broken glass than those originally cued with the verb "hit."

The context often determines whether the destination will believe or disbelieve the message received. For instance, imagine a little boy running up to his mother, exclaiming: "Mummy, mummy, there is a tiger in the backyard." More likely than not, his mother will reply: "Johnny, stop making up stories!" Suppose, however, that the family lives in Venice, Florida, practically next door to the Winter Quarters of a famous circus which, the mother is fully aware, features a "Big Cats" act. The little boy's exclamation is more likely to be given credence than not.

The diagrams pictured in Figs. 1 and 2 misleadingly suggest that the systems represented are static. All semiotic systems are, to the contrary, not only dynamic, but adaptive, that is, self-regulated to adapt both to the external context (conditions of environment) and the internal context (circumstances inherent within the system itself). At successive points, intelligence mechanisms come into play about system conditions which can, accordingly, activate and shape coping responses; their flow is commonly described as a *"feed process" (Bogart 1980). Feed processes typically move, in mutually complementary fashion, forward as well as backward, forming loops. Thus the source normally checks whether the launched message stream reaches the destination according to expectation (*"feedforward"), whereas the destination tends to continually confirm or disconfirm this (*"feedback") to the source. Feedforward is like a trend forecast that biases perception and enables the source to adjust its performance in anticipation of changeful happenings; in the favorable case, it may facilitate the avoidance of mistakes. *Feedback brings into the frame information about the working efficiency of the system itself -- information which is then "fed back" into the system, thus enabling adjustments on the basis of results accomplished.

An example of feedforward, taken from familiar organizational surroundings, is budgetary planning: the Vice-President for Research and Engineering (the source) tells a department manager (the destination) by a memo (the message) how much money the department, say, of the Apex Corporation, may spend during the coming year, and he then designs, or redesigns, the department's activities on the basis of this "foreknowledge." A different example: Many predators (the source) -- including various raptors, bats, wolves, lions, polar bears -- capture their prey (the destination) by a maneuver called "interception" (of the message). This means that the predator aims not at where the quarry is, but where it is most likely to be at the moment of impact, that is, a precise point ahead of the quarry in its calculated trajectory.

A common example of feedback comes from a habitual university setting. As I (the source) deliver a lecture (my message) to my class (the destination), I unintermittedly monitor the students' fluctuating level of engrossment or tedium by way of their acoustic and optic messages broadcast to me, wittingly or unwittingly, via a feedback loop; conscientiously, I endeavor to attune my presentation in conformity with their expressions. A different example: My heartbeat (the source) is slowed or speeded by a complex of neural and humoral factors (the message) by the vagal and sympathetic cardiac efferents (channels); changes from the normal rhythm are reported ("fed back") by sensitive interoceptors (other channels) to the brain (the destination), specifying factors such as timing, volume, and pressure of each pulse. This feedback loop between heart and brain provides an oscillatory input to my central nervous system on the basis of which vital readjustments can be effected.

The message received (and finally interpreted) by the destination is, in practice, seldom identical with the message sent (after being formulated) by the source; in other words, the output of the channel generally does not agree with its input. The discrepancy $M^s \neq M^d$, may be due to random and persistent disturbances that variously intrude into the system and obscure the clarity or quality of the message or, in extreme cases, obliterate its comprehension entirely. A channel might also, say, for secrecy, contain a cryptographic scrambling device. Such disarrangements, which make the output unpredictable even when the input is known, are called *noise. To circumvent noise and thereby to decrease the probability of transmission errors, the source habitually introjects *redundancy. There are many kinds of noise and many techniques for overcoming it, but always at a price -- as, for instance, slowing the source (and thus the entire transaction) down, or in other ways.

Imagine, for example an airport traffic controller (the source) attempting to convey precise landing instructions (the message) to a pilot (the destination) by radio (the channel) during an electric storm (noisy environmental context). One means -- perhaps the simplest -- whereby the controller can introduce redundancy to ensure reasonably error-free reception in such a high-risk situation is to reiterate all or parts of his original message, even at the expense of slowing him -- and the process of landing -- appreciably. After the delivery of every message-instance, the controller might ask (feedforward): "Do you copy?" The pilot will repeat what he understands his instructions to be (feedback). If he judges that a satisfactory consensus has been reached, he might so acknowledge with the code "Roger....," and conclude with "...out." A different example: When I utter a sentence, M^1, in the presence of light, I simultaneously engage in a wide array of other bodily movements, $M^{2,3...n}$, some of them audible ("paraphonetic"), most of them visible (avocal as well as averbal). M^1 and $M^{2,3...n}$ are always partially redundant, a welcome fact which, under noisy conditions, reduces the degree of misunderstanding between the communicants. The force of this everyday example can be appreciated by turning off the sound on your television set, or, alternatively, by leaving on the sound by masking the image. Incidentally, geneticists have found that the relation between the nucleic acid code (a four-letter code) and the protein code (a twenty-letter code) -- the genetic code -- is replete with natural redundancy, since several groups of three nucleotides, or triplets, along the nucleic acid chain, define the same amino acids along the protein chain (i.e., these groups are synonymous). Some amino acids have as many as six codons; Jacob (1965:25) has commented on their abundance in the inventory of synonymous triplets: "...redundancy gives a certain suppleness to the script of heredity."

Types of Messages

We have already seen that human beings are capable of dual means of communication: verbal and averbal. These are, in daily practice, intimately intertwined, and either mutually redundant, reinforc-

ing, or, as the case may be, contradictory.

Another classification cross-cuts the above. Message type -- ideally conceived -- are either *iconic, or *indexical, or *symbolic. In actuality, most messages are a combination of two or all three aspects, stacked in a contextually appropriate hierarchy, which shifts over time as the context alters. Every natural language consists of a complex interplay of subtly shifting iconic, indexical, and symbolic signs (Jakobson 1965:26).

An iconic message is one which resembles -- according to some conventionally accepted criterion -- some agent of the real world to which it refers. When Julius Caesar said: Veni, vidi, vici ("I came, I saw, I conquered"), the order of the three verbs he used iconically represented the order of his three successive actions in Gaul. This is an example of verbally expressed syntactic iconicity. Images, such as drawings or photographs, are commonly utilized icons in our culture: there is an assumed isomorphism between the pictorial representation and the thing represented. An example is our Star Spangled Banner: what is iconic about the United States flag is the fact that each of the fifty white stars in a single blue canton "stands for" one of the fifty states in the present Union, whereas each of the thirteen stripes "stands for" one of the Colonies that originally formed the Union (Sebeok 1976:121). The important point here is that their iconic relations can be grasped only by those already informed of the code, or convention (viz., American history) being used. There are other aspects of our flag which are indexical and symbolic; the aspect that predominates is always a function of the context (loc. cit.).

An indexical message is one which "points to" an object or is a sample of it. Verbal indexes are, for one set of examples, all pronouns: "I" means "me" when I utter it; but when Ronald Reagan utters the same combination of phonemes, they add up to "Ronald Reagan." "Today" means "Monday" as I am writing this sentence; had I written it yesterday, "today" would have meant "Sunday." If I place onto a marker a tiny box containing radioactive waste from a nuclear powerplant, this could (in that context) be an index of a larger quantity of waste resulting from reprocessed spent fuel in the vicinity -- say, encapsulated in a canister sunk far beneath the surface sample.

A symbolic message is one whose relationship to the "state of affairs" that it purports to represent is arbitrary, that is, understandable because of a preexisting social convention which specifies that the message will, to all who concur, stand for thus-and-so. For instance, the spoken word "dig" will be understood by all who are privy to the code known as "modern spoken English" as, roughly, equivalent to "excavate" (and associated notions), given the right context; (in other contexts, the same morpheme might mean "thrust," "reside," "poke," "apprehend," "enjoy," and so forth -- derivative extensions commonly called "metamorphic meanings"). Symbols, of course, can be encoded in various other modalities. The American flag is also a symbol triggering deep emotional responses -- say, in the context of a burial at Arlington National Cemetery.

The technical word used for highly formalized symbols in the visual mode is *emblem. Examples of emblems are the abstract wheelchair design (Fig. 3), widely recognized as a way of making it known that there is a facility nearby giving access to a handicapped person; and the so-called trefoil (Fig. 4), generally accepted as a biohazard warning.

Fig. 3

Access for the handicapped

Fig. 4

Trefoil for biohazard warning

Situated within a downward directing arrow in a canary-yellow triangle (Fig. 5), the trefoil is meant to be interpreted as "Caution, biohazardous waste buried here," i.e., below where the arrow points:

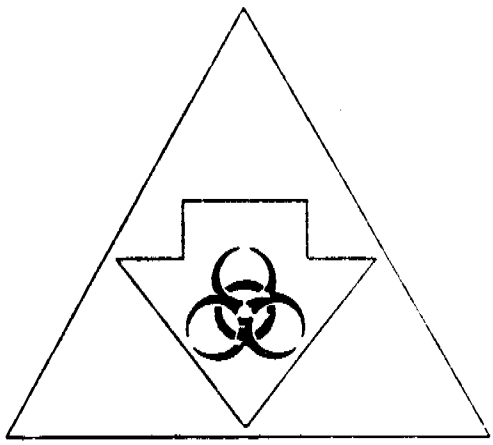

Fig. 5

Caution, biohazardous waste buried here

Each mode of communication -- iconic, indexical, symbolic (or emblematic) -- has a set of advantages and a corresponding set of disadvantages, which are both context-bound (see further Sebeok 1976, Ch. 8). Since the context is far from predictable at any stage over the next 10,000 years, and, with the passage of time, is bound to become increasingly equivocal, it will be recommended that all signs be constructed of a mixture of the three modes. While this intermingling will still not be fail-safe, it is certain that the more redundancy is built into the system, the more this will tend to ensure accurate decoding by any destination. The implications of this statement are further developed below.

Some Problems of Imaging

At this point, some comments are in order about certain predictable problems involving iconic, specifically, image-based coding. Two standard books on this subject are by Kennedy (1974) and by Hagen (1980); see also Cabe's compendiary yet comprehensive account (1980), for a recent review of the most critical issues. It should be stressed that there is substantial disagreement on the extent to which pictorial perception depends on specific cultural experience, certainly a major source for human individual differences. Obviously, pictures give some humans some information on some occasions; but the "how" and "when" are complicated questions, and the answers are neither obvious nor should be taken for granted in circumstances as delicate as our project demands. There are stick-figures, cartoons, sketches, paintings, photographs, and a host of other possibilities for pictorial representation, with varying degrees of accuracy; the perception of all depictions, moreover, varies across species, cultures, and times. For example in the crowd scene in Fig. 6, are the people fighting, dancing, or engaged in some other activity?

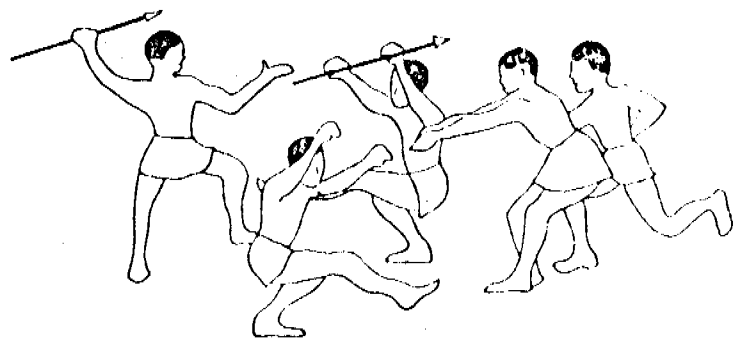

Fig. 6

After Kennedy (1974), p. 70, Fig. 10

What is intimated here is by no means that images should not be used, but rather that they be selected with extreme forethought, and that they always be incorporated into a framework that judiciously intermingles icons with symbols, supplementing the pair with indexes whenever that, too, is feasible.

The best guess of informed scientists, based on terrestrial cases, is that the "greeting cards" carried on the Pioneer and Voyager probes would more likely than

not be devoid of meaning to "extraterrestrial intelligence," because of a lack of common context as well as distinct wiring of perceptual apparatus. Even if "intelligent" life beyond earth were to exist, "the weight of evolution stresses the unlikelihood of the appearance of humanoid forms elsewhere in the Universe" (Feinberg and Shapiro 1980:409-410), and it is therefore wholly unreasonable to expect that a creature possessing a comparable apparatus for decoding and interpreting information has been produced by independent biological processes on another planet. Even here on earth every species incorporates a different Umwelt, or "cognitive map," of its environment (Uexküll 1980:291-388), no one of which can be considered "more real" than any other.

Channels

Every form of physical energy propagation can be used as a channel for conveying messages. To mention only the most common links used in one corner or another of the animal kingdom, these are: chemical, optical, acoustic, tactile, electric, temperature-based, different combinations of the aforementioned, and others. It is important, furthermore, to appreciate that human senses register only a small portion of ambient stimuli. Acoustically and optically, for example, as already pointed out, we are dependent upon a narrow range of hearing and seeing, i.e., we can register only restricted frequencies. It is very difficult to foretell what sensory prostheses will be at man's disposal in future decades and centuries, and one must further allow for the possibility -- indeed, in the opinion of many, likelihood -- that "human interference" will be carried out only indirectly by man, through the mediation of programmed robots equipped perceptually by unpredictable bionic devices. The problem of what constellation of channels to store the information to be transmitted into the future in thus assumes considerable importance; here, once again, redundancy offers the best hope; all channels that seem technically feasible should be utilized. For instance, if the site can be rendered repulsively malodorous for a lengthy period, that would be, at least provisionally, a deterrent against casual exploration; no one, however, would advocate exclusive reliance upon the olfactory channel as a "final solution."

Written Records and Decipherment

Excellent historical surveys of written records and decipherment were published by Gelb, among other works of his, under the above title (1973), with an extensive bibliography on the subject; and, more recently (Gelb 1980), with an emphasis on the semiotic aspects, especially within the frame of visual communication. The geographical scope includes the long stretch of land extending from Gibraltar to the Yellow Sea. All types of records, their frequency and variety, epigraphy and paleography, are discussed. In all instances, the time-depth is perhaps a third of the time-span of 10,000 years we are concerned with here (although -- arguably -- there seems to be evidence of a non-utilitarian use of technology and of a periodic employment of different types of manufactured symbols up to 100,000 years ago, or perhaps even a quarter of a million, in the evolution of capacity and aspects of man's cultural development). The problems of decipherment discussed by Gelb, a leading authority, seem, however, to have but marginal bearing, for they deal with:

i) decipherment of unknown writings and languages (e.g., hieroglyphic Egyptian, cuneiform Akkadian, and hieroglyphic Hittite);

ii) decipherment of unknown writings used for known languages (e.g., Phoenician and Ugaritic writings, cuneiform Old Persian, Cypriote, and Old (runic) Turkish); and

iii) interpretation of unknown languages in known writings (e.g., Etruscan).

The general rule that applies is that the degree of difficulty of the recovery of extinct languages is linked directly to the degree of relationship between the

language to be recovered and comparable languages (Gelb 1973:270). Methods of decipherment, and the steps involved in this process are briefly but cogently discussed by Gelb. For a much fuller as well as more general discussion of the methodological problems involved, see the outstanding book of Kahn (1967).

Kahn's consideration of the Rosetta stone (ibid:905-910) is especially illuminating. Although the stone's importance was instantly recognized as a possible key to a solution of the mystery of hieroglyphics when it was found, at the end of the eighteenth century, the important point to keep in mind is that its "mere existence...did not make solution automatic" (ibid:906), as is popularly believed. Jean-François Champollion resolved the riddle only in the Fall of 1822. For this and other more technical reasons, the "lesson" of the Rosetta stone is not relevant to the matters at hand.

Gelb (1980:19-20) lists the various systems and devices available to human beings. His initial division is between (a) Momentary, and (b) Stable. The first category is not applicable here. The second category enumerates three sets of subcategories, to wit:

(1) "Semasiographic devices or forerunners of writing by means of markings on objects or on any more or less durable material or by means of shapes or color of objects..." Some of these are descriptive-representational devices, which include both pictorial communication and pictorial art, magico-religious representation and narrative representation, as well as seal iconography. For the problem at hand, some sort of narrative representation will, undoubtedly, be required, although it will not be sufficient.

(2) "Phonographic systems or full writing, by means of markings characterized by close correlation with [some] oral language." This group includes logo-syllabic systems, syllabic systems, and alphabetic systems.

(3) "Para-graphic devices or systems, by means of markings occurring within and in addition to writing proper characterized by loose correlation with oral language." Here belong comic strips and cartoons on the one hand, and emblems of the sort advocated by various members of the Task Force.

The important point is that the principle of redundancy advocated here requires that as many stable systems and devices be utilized as imagination suggests and technology permits.

For the record, it should be added that the world's oldest clay tablets date only from 3000 B.C., although it is theorized that people may have begun to record tax receipts, in the form of clay balls, cylinders, and cones -- in a word, tokens -- perhaps as far back as 8500 B.C. According to Denise Schmandt-Besserat (1981), ancient Sumerians kept the tokens which were used to stamp tablets to keep some sort of record, probably each representing a specific amount of a specific commodity, and, by about 3500 B.C., began storing the tokens inside hollow clay balls, indexing the tokens by making an impression of each token on the outside of the ball. Her view is that, by 3100 B.C., it was realized that the actual, material tokens need not be inside the ball, but that the "indexical" impression on the outside of the ball would suffice. Herein may lie writing's true origins, depending upon the definition of writing adopted; her term for the impressed tablets is "proto-writing," emphasizing their transitional character, as between three-dimensional tokens to their graphic representation.

Recommendations (and Related Considerations)

A. The opening sentence of Harrison's classic survey of Pandora's Box (1900:99), on the changing aspects of this celebrated mythical symbol, begins: "There is a strange fascination about a mythological character that has retained its vitality up to our own day...." This familiar myth -- which occurs in countless verbal and pictorial variants since Hesiod's famous

account of the Pandora story in his Works and Days (Panofsky and Panofsky 1962) -- deals with the woman, fashioned, upon orders from Zeus, by Hephaestus into a body out of clay and water, endowed by vital force and a human voice, and sent by the ruler of Olympus as a gift to Epimetheus, the brother of Prometheus. Epimetheus was enchanted by Pandora; the beautiful mischief brought in her arms a great vase, raised its forbidden lid, thus enabling every evil the flesh is heir to to escape and spread about the earth (Hope alone remained). Pandora and her proverbial box (or jar,[3] or cask, or vase) appears as an emblem of misery and destruction as in these representative illustrations (Figs. 7 and 8).

These persistent and widely diffused mythological and iconographic resonances of the assignment of which the Task Force is seeking a resolution leads to the first recommendation, to wit: that information be launched and artificially passed on into the short-term and long-term future with the supplementary aid of folkloristic devices, in particular a combination of an artificially created and nurtured ritual-and-legend. The most positive aspect of such a procedure is that it need not be geographically localized, or tied to any one language-and-culture (although, clearly, when linguistic and ethnic boundaries are crossed, both the verbal component and the associated set of rites are likely to undergo changes and lead to an attenuation of the original rationale).

The legend-and-ritual, as now envisaged, would be tantamount to laying a "false trail," meaning that the uninitiated will be steered away from the hazardous site for reasons other than the scientific knowledge of the possibility of radiation and its implications; essentially, the reason would be accumulated superstition to shun a certain area permanently.

A ritual annually renewed can be foreseen, with the legend retold year-by-year (with, presumably, slight variations). The actual "truth" would be entrusted exclusively to an -- as it were -- "atomic priesthood," that is, a commission of knowledgeable physicists, experts in radiation sickness, anthropologists, linguists, psychologists, semioticians, and whatever additional administrative expertise may be called for now and in the future. Membership in this elite "priesthood" would be self-selective over time. The notion of a "priesthood" created to watch over "waste" has also been suggested by Darnay (1976, 1981); it is, of course, merely a colorful term for a self-perpetuating, government-independent committee. In another, wider, context, the more menacing expression, the Nuclear Barons, is used for "an international elite of scientists, engineers, politicians, administrators, and military officers who brought atomic energy under control" (Pringle and Spigelman 1981:ix).

The best mechanism for embarking upon a novel tradition, along the lines suggested, is at present, unclear. Folklore specialists consulted have advised that they know of no precedent, nor could they think of a parallel situation, except the well-known, but ineffectual, curses associated with the burial sites (viz., pyramids) of some Egyptian Pharaohs, e.g., of the 18th dynasty, which did not deter greedy, and, presumably, illiterate graverobbers from digging for "hidden treasure."

B. Although the problems of waste storage are being studied in other countries -- among them, Canada, France (which began research on vitrification and other forms of waste solidification in the late 1950's), Sweden, and West Germany (which alone has chosen a site for the final resting place of some of its garbage) -- and demonstration projects underway abroad are, in some places and some respects,

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[3]The original Greek word pithos, commonly mistranslated as "box," referred to a huge earthenware storage jar, "often large enough to serve as a receptacle for the dead...," i.e., that either stands on or is partly buried in the earth; (see Harrison 1900:100, and Panofsky and Panofsky 1962:7).

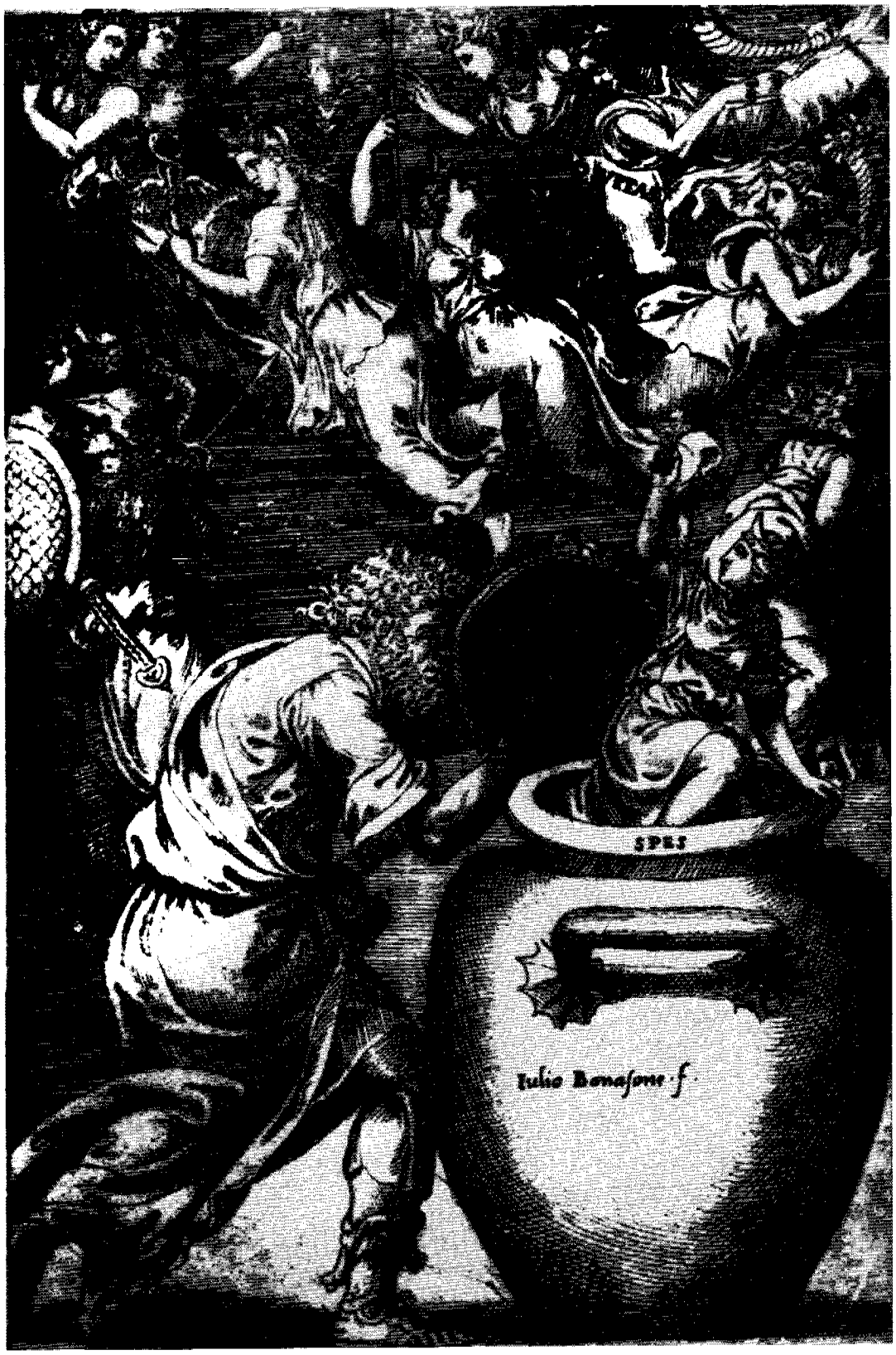

Fig. 7

Engraving by Giulio Bonasone, "Man's Opening the Fateful Vessel" (btw. 1531-1574).

Fig. 8

Gouache by Max Beckman, "Pandora's Box"
(begun in 1936, but thoroughly repainted in 1947)

technically further along than those in the U.S., the human intrusion factor is scarcely studied abroad (cf., however, Johansson and Steen 1981). This means that planning should begin immediately to internationalize the kinds of communication measures discussed in this paper, and other Task Force reports. The ultimate design adopted should enjoy the benefit of world-wide thinking about the problems we face and their world-wide implications.

It should be noted, in passing, that the first issue of Nuclear and Chemical Waste Management: An International Journal of Hazardous Waste Technology was begun in 1980, its announced purpose being to serve "as a forum to facilitate the communication in this area on a global basis."

C. Consideration should be given, at least in passing, to communication in artificial languages, which are mainly of two kinds, general purpose languages, and languages restricted to the communication of some specified subject matter. The use of mathematical formulae is an old and conspicuous special purpose language, and may safely be assumed to embody the physical laws of the universe, understandable throughout the cosmos. Usually, mathematical communication consists of formulae surrounded by bits of vernacular. While the exclusive use of mathematical communication is not recommended, especially not for rite-bound messages, it is reasonable to anticipate a limited use in (a) metamessages and (b) technical messages to be "permanently" stored in archives, libraries, computers, and other long-term repositories. On this subject, see further Freudenthal (1974), and the same author's earlier treatise, Lincos: Design of a Language for Cosmic Intercourse (1960).

D. One of the pivotal concepts undergirding this whole paper is the notion of redundancy. In information theory, this term refers to a property of an information source whose *entropy (cf. Rifkin 1980), H, is less than the maximum entropy (H_{max}) that could be obtained with the same string of messages. Redundancy (or one minus the relative entropy of the source, i.e., the ratio of the actual entropy to H_{max}) is an extremely important matter because it reflects the extent to which the efficiency of a communication system can be brought up to the desired standard by improvements in the encoding source (i.e., in our present time).

When the channel is noisy -- as most often it is bound to be -- so that some messages are received erroneously, containing certain distortions, certain extraneous material, the introduction of redundancy will make it much more probable that some or all of the errors may be corrected. Therefore, the purpose of error-correcting codes is to intromit redundancy in a known manner such that corrections can be made at the receiving point -- i.e., by the destination (i.e., in a future era) -- without any further reference to the message source (which, by the nature of the case we are considering, would be impossible).

E. Finally, a carefully considered over-all recommendation is urged about the entirety of the communication system under deliberation. This is based on the conviction that all human thinking must be in continuity with the past, but also an ineluctable corollary of this proposition, namely, that information tends to decay over time (i.e., the entropy continues to increase eventually resulting in total incomprehensibility). This is not merely an empirical observation -- witness the evolution of Modern English from Anglo-Saxon, through Middle English -- but a consequence, more generally, of the Second Law of Thermodynamics. These related concepts are authoritatively discussed, in layman's language, in Wiener 1950; the fact, he says (ibid.:88), that information may be dissipated but not gained is one form of the Second Law of Thermodynamics, which also states that (in an isolated system) the probability that the entropy shall decrease is zero (ibid.:22).

What to do to counter the passage from negentropy to ultimate entropy?

What is being proposed here is a so-called "relay system" of information transmission, which rests on a very simple

scheme: to divide the 10,000 year epoch envisaged into manageable segments of shorter, and, presumably, reasonably foreseeable periods. Assuming that 10,000 years is equivalent to ~300 generations of humankind, it is recommended that the messages at the burial site be designed for only three generations ahead, to wit, our children, grandchildren, and great-grandchildren. A clear advantage of any such system would be that the verbal portion could be Modern English, while the averbal portion could easily be extrapolated from existing and universally understood pictorial emblematic strings (e.g., cartoons, stick-figures, or the like).

This message, however, would have to be supplemented by a metamessage -- coded in the same combination of familiar verbal/averbal signs -- incorporating a plea and a warning that the object-message at the site be renewed by whatever coding devices seem to be maximally efficient, roughly, 250 years hence. That future object-message should, in turn, incorporate a similar metamessage for the generation 500 years from now to act comparably, and so on, and on, up to 10,000 years ahead.

As for the more permanently stored, elaborated, and scientifically accurate information in archives of the future, a similar set of instructions should make it clear that, as the information begins to decay, it should be updated, and also expanded in the light of improved science, engineering, and technology.

The disadvantage of the relay system is, of course, that there is no assurance that future generations would obey the injunctions of the past. The "atomic priesthood" would be charged with the added responsibility of seeing to it that our behest, as embodied in the cumulative sequence of metamessages, is to be heeded -- if not for legal reasons, then for moral reasons, with perhaps the veiled threat that to ignore the mandate would be tantamount to inviting some sort of 'supernatural retribution'.

Summary

The generalization that all natural languages -- and, by extension, all of man's communications systems -- change over time is widely accepted. Such semiotic systems, moreover, tend to undergo progressive changes such that their significative functions become unreliable (e.g., Middle English to us), or even totally incomprehensible (e.g., Old English to us), when future generations attempt to comprehend them. This is true, in varying degree, of written forms as well as of speech.

It follows that no fail-safe method of communication can be envisaged ±10,000 years ahead. To be effective, the intended messages have to be recoded, and recoded again and again, at relatively brief intervals. For this reason, a "relay-system" of communiction is strongly recommended, with a built-in enforcement mechanism, for dramatic emphasis here dubbed an "atomic priesthood," i.e., a commission, relatively independent of future political currents, self-selective in membership, using whatever devices for enforcement are at its disposal, including those of a folkloristic character.

In any event, all messages should be as redundant as possible -- a judicious mixture of verbal and averbal components, preferably containing a mixture of iconic, indexical, and symbolic elements.

The international aspects of the task should be kept in view, so far as feasible, from the outset.

Epilogue

"Our world...is an entirely different world from what it was a few years ago. The problems of human life are problems of adjustment, and to adjust ourselves to anything we men have first to know something about this 'something' we have to adjust ourselves to. Happiness is becoming increasingly rare among modern men, and will remain so as long as we persist in applying animal standards to ourselves....

What will mankind do? I really do not know. Our Fido ways are so unspeakably deep-rooted that perhaps our future is hopeless. It is not unknown to scientists that the world is mostly managed by extremely ignorant men, and organized for the survival of the unfit, which of course means ultimately misery and extinction for all" (Korzybski 1926:50-51).†

†For a later, and more optimistic prospect, see Korzybski's Science and Sanity (1933) and his subsequent papers wherein he presented a program for amelioration of the problems he described in 1926. Indeed, he founded the Institute of General Semantics in 1938 to work to that end. Ed.

GLOSSARY OF TECHNICAL TERMS

AVERBAL: not linguistic.

CHANNEL: a medium wherein a message travels from source to destination.

CODE: an agreed transformation, or set of unambiguous rules, whereby messages are converted from one representation to another.

CONTEXT: broadly, the environment of a message; narrowly, all preceding and/or following messages that bear on their significance.

DECODING: a transformation, whereby, by operation of code rules, a destination alters an incoming message from one representation to another.

DESTINATION: where a message ends, i.e., is successively decoded and interpreted.

EMBLEM: a highly formalized symbol, usually in the visual modality.

ENCODING: transformation, whereby, by operation of code rules, a source alters a message from one representation to another.

ENTROPY: a term strictly used in statistical thermodynamics; and loosely used in semiotics to refer to the information rate of a message source.

FEEDBACK: kind of feed mechanism that functions to detect an error in a communication system after the error has already occurred.

FEED MECHANISM: a cover term for three types of self-regulated control systems: feedback, feedforward, feedwithin.

FORMULATION: an electro-chemical precoding process assumed to occur in a vertebrate's central nervous system prior to the recoding of a message in an externally communicable representation; generation.

ICON: a sign is said to be iconic when there is a topological similarity between the signifier and its denotata.

INDEX: a sign is said to be indexic in so far as a signifier is contiguous with its signified, or is a sample of it.

INTERPRETATION: an electro-chemical postcoding process assumed to occur in a vertebrate's central nervous system after the recoding of the message as received.

LANGUAGE: a uniquely human modeling system, such that signifiers (commonly: sounds or their graphic representation) and signifieds (meanings) are coupled over an infinite domain; verbal communication.

LINGUISTICS: the academic discipline devoted to formal studies of language and of natural languages.

MESSAGE: in communication, a sign or string of signs.

MESSAGE, CONVENTIONAL: a sign or a string of signs whose power to signify is thought to depend on prior agreement.

MESSAGE, NATURAL: a sign or a string of signs signifying the same things at all times and in all places.

MULTIMESSAGE: a signifier that has a number of distinct meanings, choice of interpretation depending on the time and/or the place.

NOISE: disturbances which do not represent any part of the messages from a specified source; unwanted signs.

PRAGMATICS: that branch of semiotics which studies the uses and the effects of messages; a term parallel to "Syntactics" and "Semantics."

REDUNDANCY: a property assigned to a source by virtue of an excess of rules whereby it becomes increasingly likely that mistakes in reception will be minimized.

SEMIOLOGY: one common synonym for "Semiotics."

SEMIOSIS: the action of a sign, involving three subjects -- a sign, its object, and its interpretant.

SEMIOTICS: the doctrine, science, or theory of signs; the subject matter of semiotics is the exchange of any messages whatever and of the system of signs which underlie them.

SIGNIFICATION: the meaning, or sense, of a message.

SOURCE: where a message begins, i.e., is successively formulated and encoded.

SYMBOL: a sign without either similarity or contiguity, but only with a conventional link between its signifier and its denotata, and with an intensional class for its designator.

TRANSDUCTION: transformation from one form of energy into another.

VERBAL: linguistic.

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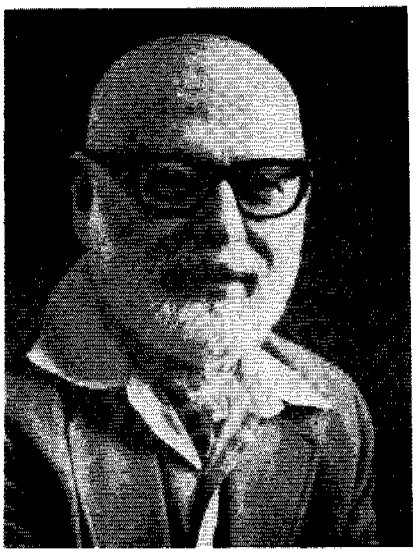

THOMAS A. SEBEOK

THOMAS A. SEBEOK is Distinguished Professor of Linguistics and Semiotics, Professor of Anthropology, and Professor of Uralic and Altaic Studies at Indiana University. An outstanding scholar, writer and lecturer in a number of fields, he is well known especially for his work in semiotics, zoosemiotics, and many aspects of linguistics. He has written authoritatively also on a wide range of subjects such as mythology, folklore, ethology, stylistics, the nature of the arts, etc.

Dr. Sebeok, born in Budapest in 1920, came to this country at the age of seventeen, and became a U.S. citizen. He received his B.A. at the University of Chicago, his M.A. and Ph.D. at Princeton University. Besides being on the faculty of Indiana University since 1943, he has had visiting appointments at twenty or more universities throughout this country and abroad, and is Phi Beta Kappa Visiting Scholar (1981-82). At Indiana University he is at present Chairman of the Research Center for Language and Semiotic Studies and Chairman of the Graduate Program in Semiotic Studies.

He was President of the Linguistic Society of America (1975), Executive Director of the Semiotic Society of America and Chairman of its Editorial Board, and is a Fellow or member of numerous other scholarly associations. A bibliography of his writings since 1942 covers over forty pages, and he has also edited many professional serials. His recent books include:

The Sign & Its Masters (1979)

Speaking of Apes, co-authored and co-edited with Jean Umiker-Sebeok (1980)

"You Know My Method": A Juxtaposition of Charles S. Peirce and Sherlock Holmes, co-authored with Jean Umiker-Sebeok (1980)

The Play of Musement (1981)

He was the Editor of fourteen volumes of *Current Trends in Linguistics*, Editor of *How Animals Communicate* (1977), is currently editing an international *Encyclopedic Dictionary of Semiotics*, and has been the Editor-in-Chief of *Semiotica* since its founding in 1969.

The papers which follow are drawn from the conference held at the United Nations, "Toward Better Understanding among Nations," on November 7, 1981. Not everything presented there is included here. Some presentations were delivered extempore (e.g., Mr. Doudou Diene's) and were not sufficiently well recorded to allow for transcription and printing. The same circumstance applies to Dr. Rachel Lauer's contribution; however, we are able to include a reprint of her entire article which appeared in The Humanist in which she spells out a central theme of her remarks at the U.N. Mr. Harry Maynard's paper was also previously published in The Humanist. Professor Allen Walker Read's paper was published in Etc. under an agreement between the Institute of General Semantics and the International Society for General Semantics whereby both sponsoring organizations would have access to papers delivered at the conference.

The contributions of the 'non-general semanticists' have not been edited to reflect Bulletin usage except as relates to the case of quotation marks and the distinction between "semantics" and "general semantics." Ed.

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