

The United Nations, Information Theory
Cybernetics, and Decision Theory

The Challenge of the Earth Satellite:

At the Institute of Radio Engineers Aeronautical Communications Symposium in Utica, New York, November 7, 1957, the editor of Flying (magazine), Mr. Gill Robb Wilson, gave a challenging speech. He was gravely concerned over the failure of the United States to be first in launching a satellite into the "air environment". Mr. Wilson was upset by the situation in which a great country, having vast resources and democratic ideals with great respect for human dignity, failed to maintain leadership in such an important area of research and development as the earth satellite program. He was concerned that a "Godless" country like the Soviet Union was getting ahead of us in the training of scientists and engineers. He stated that our country is waiting for some great leader like Moses to show us the way out of the present situation. Mr. Wilson expressed a feeling of personal failure for not taking more vigorous action when he saw decisions being made in respect to research and development on the air environment which he felt were inadequate. He felt that in the United States we have failed to live up to our individual responsibility. He urged people who have an understanding of the important problems of our country to speak out and fight for consideration of their ideas.

My response to Mr. Wilson's challenge is to examine the relation between science and society to see what problems exist in the United States and in the Soviet Union in a comparative way to see if any lessons can be learned from the situation. An all out expansion of our efforts in missiles and satellites and in training of scientists may not be the answer. A simple push to catch up and overtake may be a brute force method dealing only with quantity or amount of effort. An examination of the structure or quality of what is going on may give us greater insight.

Information Theory in the USSR

Evaluation of the information theory developments in the Soviet Union as reported at the Western Electronics Show and Convention (WESCON), August 1957, leads to some interesting hypotheses. Namely, the leaders of the Communist Party of the Soviet Union were initially afraid of the political implications of information theory. The most plausible explanation of the opposition to pursuit of information theory, is the potential analogy of the equation for maximizing the information content of a message in analysing sociological systems.

In information theory the information content of a message of n symbols, where each symbol has a probability of occurrence of p_n is:

$$H = \left[p_1 \log p_1 + p_2 \log p_2 + \dots + p_n \log p_n \right]$$

The condition for maximizing H for a fixed n, is that:

$$p_1 = p_2 = \dots = p_n,$$

i.e., the probabilities for each symbol are equal¹

Although sociological systems are much more complicated than a simple telegraph message the potential analogy was apparently sufficiently significant to the Russians to cause objections to information theory until 1953(2).

According to Dr. Green, the Russians withdrew their opposition to Information Theory in 1953 and since then have allocated substantial effort in this area. They have already developed an alternative proof of one of Shannon's Theorem which is a more rigorous proof.

It appears plausible to me that the Russians have decided that it is more important for them to be pioneers in science and mathematics than to suppress areas of science which might invalidate parts of their philosophy. Perhaps we should utilize the potential sociological analogy of information theory both to support our own democratic ideals and as a criterion in making judgements in our relations with other countries.

In conversations with other engineers at the IRE Symposium in Utica November 6th and 7th I found that there was a general awareness of American engineers of the present intensive work on Information theory in the USSR, but the sensitivity of the Russians to the potential political implication of Information Theory was generally unknown. Therefore, I brought Dr. Green's paper to the attention of many of the engineers with whom I talked.

A Visit to United Nations

On Saturday, November 9th, I visited the United Nations District, New York. It seemed strange to leave the United States to enter a district under the jurisdiction of the United Nations and then walk back into the United States of American without having to go through customs inspection and obtain a passport, etc. I found it thrilling experience to visit the meeting rooms of the General Assembly, Security Council, Trusteeship Council, and Economic Council. The spirit of the growing United Nations made me think that the old League of Nations Association song, written by Josephine Daskam Bacon, has more of a real feeling of the future:

Brother, sing your country's anthem
Shout your land's undying fame;
Light the wondrous tale of nations
With your people's golden name.
Tell your father's noble story,
Raise on high your country's sign.

Join, then, in the final glory --
 Brother, lift your flag with mine!

Hail the sun of peace, new rising,
 Hold the war clouds closer furled
 Blend our banners, O my brother,
 In the rainbow of the world!
 Red as blood, and blue as heaven,
 Wise as age, and proud as youth,
 Melt our colors, words woven,
 In the great white light of Truth!

Build the road of Peace before us,
 Build it wide and deep and long;
 Speed the slow and check the eager,
 Help the weak and curb the strong,
 None shall push aside another,
 None shall let another fall:
 March beside me, O my brother,
 All for one, and one for all!

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 Nations Association, Inc.)

The Taxi-Driver-Philosopher

On leaving the United Nations District I hailed a taxi cab to go downtown. The driver was very talkative. A group from some boys military school has just visited the United Nations. This set off the cab driver on talk about militarism and the U. N. He asked why do we have to have all this military preparation; why can the U. N. move faster in getting all the nations of the world to cooperate? The cab driver went on to ask why do we have to have some conflicting religions in the world; why can't people develop a universal religion out of the best ideas of all the different religions?

Although the cab driver's ideas were over simplified and impractical, I admire him for communicating his feelings and strivings for a world in which all races, nations, and faiths can cooperate in harmony. In a way he is a spokesman for many people who have a desire for a more stable economy and wish to see a world free from war, the danger of war.

The Story of Mankind

Saturday afternoon I saw the movie: "The Story of Mankind", which has some features in common with the book of the same title by Hendrik Willem Van Loon⁽³⁾. It is an inspiring and thought provoking movie about a hypothetical meeting of the judges of "outer space" sitting in judgement

upon the people of the earth who have invented a super hydrogen bomb which is capable of destroying all life on the earth. The judges are debating whether they should intervene to give man another chance or to let him destroy himself. Counsel for mankind brought an exhibit illustrating the great leaders who have led man to greater heights of civilization. The devil's advocate brought in exhibits from history of man's tyranny and debauchery. I rate "The Story of Mankind" as a very excellent and important movie.

A Second Visit to the United Nations

In my hurry to get to the theater to see "The Story of Mankind" I had taken a brief tour of the United Nations. Since there was some time left before closing time at the U. N. after the movie I raced back to complete my tour at the U. N. and to browse in the bookstore in the basement of the U. N. building.

Artists from different countries of the world have painted murals depicting mankind's striving for peace and international cooperation. The U. N. bookstore was very interesting. There are many U. N. reports for sale on problems of economic stability, world health, technological development, and many other subjects discussed by various U. N. agencies and committees.

Information Theory and Human Information Systems

I found one UNESCO publication particularly interesting: "Information Theory and Human Information Systems" by D. M. MacKay⁽⁴⁾. The paper deals both with amount of information (channel capacity, redundancy, etc.) and with information-flow maps (inverse feed-back systems sometimes classified under cybernetics). The principal paragraph headings as follows indicate the scope of the article:

Introduction	Human Information System
Measuring & Map-making	Stability
Basic Ideas	Remedies for Instability
Some Uses of Measurement	Stability of Social Information Systems
Human Language	Predictability of Information Systems
Mechanical Translation	Man as an Information System
Information Retrieval	Freedom and Responsibility
Information-Flow Maps	Irrelevance of Physical Indeterminacy
A Typical Information-Flow System	

Implications for Penal Theory

The author of the above article, Dr. MacKay, formerly worked on radar, then directed research at King's College, London, on problems of high-speed electronic computation, and is now directing a group doing research into the organization of the brain as an information system. The section of predictability of information systems contains a basic theorem:

It is a property of any information system, that a complete predication of it cannot be validly represented by an active part of the system.

The application of information theory to the problem of freedom and responsibility appears highly significant. Dr. MacKay insists that the criterion of human responsibility is not in principle a behavioral but a structural one. The question is basically whether his information system is so organized that our intended description of its future state would be self-nullifying (as a description) if offered to him, because it would be self-referring. The criterion thus reduces in essence to a question of the unity or wholeness of the man's information-flow system.

Reflections in the Occurrence of a Desire for "A World at Peace"

The existence of the United Nations represents an achievement of many individuals who had a striving for a better world like the cab-driver, yet succeeded in expressing their feelings in a more concrete way such that the United Nations finally came into being, and even though weak, is growing into a potential instrument of international cooperation. Do we have to wait for rare occurrences of individuals who have both a striving for a "better world" and the ability to channel their activities along constructive lines to make forward steps in the development of civilization? The thought occurred to me that perhaps studies of child development such as those of the Gesell Institute for Child Development, New Haven, Conn., should shed some light on the probability of occurrence of this feeling or striving for a "better world". I was sure there was something in Gesell's recent book; Youth: The Years from Ten to Sixteen. I searched through the book, following clues in the index and table of contents, but couldn't find the information. I consulted a YMCA secretary who had read the book, but he couldn't recall any useful clues. I had an information retrieval problem. Trying index headings like "ethical sense" yielded a little information but it didn't seem specific enough. It was too late to phone the authors, so I nearly read half the book before I found the material. I finally found the first real clue under "Year Fourteen - Maturity Profile".

" Albert Schweitzer relates how in his fourteenth year the joys of seeking for what was true and good came upon him "like a kind of intoxication". He felt "a passionate need to think". As a philosopher he holds the 14-year-old youth in high regard and pays him a compliment. "If all of us could become what we were at fourteen, what a different place the world would be! (5)

Now I am on the right track. However, the above quotation is from a single great physician-philosopher-musician-missionary and needs to be verified by statistical data if it is to be applied generally. Under "Year Fourteen - Maturity Traits - The Growing Self".

" As he voices what he would wish for. Fourteen is not thinking of himself alone. Rather he is thinking of himself in the kind of world he would like to live in. First and foremost he wishes for a world at peace or for an end of wars. Then he wishes for a better world in general, in which there is a "unity of nations", "a union of all religions", and a "high standard of living" and "a better chance for people to grow up". More specifically he wishes that there were a more properly run government ("one that wouldn't allow taxes to go up!") and a better educational system. (6)

The above quotation Gesell implies that this striving for a "unity of nations" or peace is a general phenomena that occurs during adolescence in our culture. We may ask on what percentage of the youth studied and interviewed is the above quotation based? Gesell's study is based upon a study of 165 different subjects⁽⁷⁾. The above quotation appears to be based upon extensive interviews supported by questionnaires. An example of a question given the subject is given below:

Extract from Table 5⁽⁸⁾

Wishes

Question: If you could have three wishes, what would they be?
(Data on wish for "peace" is here extracted from Table 5)

<u>Age</u>	<u>Rank in Order of Most Frequently Occuring Wish</u>	<u>Percentage of Individuals Making Wish for Peace</u>
13	2nd	20%
14	1st	32%
15	3rd	14%
16	3rd	25%

I don't know whether the above table means that at the most 32% of adolescents put a wish for peace in the top three wishes or whether they reach this stage at different times giving a total of 92% of adolescents put a wish for peace within their top three wishes at some time in the 13 to 16 year range. At least we can say that Gosell's data give a correlation factor of at least 32% in support of Albert Schweitzer's statement.

The Cab-Driver's Wish Grows in Reality

Our cab-driver of age 40 still expresses his wishes of age 14 for a "unity of nations", "a union of all religions", and a "high standard of living" and "a better chance for people to grow up". At first I felt sad that the cab-driver had not succeeded in becoming a great leader in politics, in education, or in religion. But in reality he is performing an important function like the "keep alive" electrode in a radar TR tube. He, through his talking, may be reminding many travelers of their ideals which got pushed aside in the rush of business.

Sunday morning I attended services of The Community Church of New York. I was pleasantly surprised to find it a truly inter-racial church. Here was a group of people doing pioneering work of developing ways in which people of different racial and religious background can cooperate in a common church. The purpose of the Community Church as stated in its news bulletin is:

"This Church is an institution of religion dedicated to the service of humanity. Seeking truth in freedom, it strives to apply it in love for the cultivation of character, the fostering of fellowship in work and worship and the establishment of a righteous social order which shall bring abundant life to men. Knowing not sect, class, nation, or race, it welcomes each to the service of all"

This type of a Community Church is very important in providing a place where pioneers can work on the frontiers of problems of the cooperation of diverse human groups. I do not advocate any departure from the principle of separation of church and state.

As the complexity of our civilization increases the principle of separation of church and state may have to be reformulated in different terms. In an agricultural community the rights of the individual to religious freedom can be guaranteed by constitutional provisions prohibiting legislation establishing "an official religion". As large cities and a more general public school system the problem of separation of church and state become more closely related to the prohibition of the use of public tax funds to support particular religious groups. The advent of the more extensive use of the power of eminent domain by the state in expanding schools and universities, building freeways, and redeveloping depressed areas of our large cities raises questions as to how the principle of "freedom of religion"

can best be safe guarded under these new conditions. A redevelopment board may be assisting or retarding particular religions through its decisions in planning redevelopment projects. Perhaps a new criterion for assuring freedom of religion can be developed, based upon the maximizing of information in our society.

Science and Social Responsibility

I have long been interested in the problem of how much social responsibility should a scientist assume for the application of his work. Organizations like the Society for Social Responsibility in Science have brought scientists together who have concern for the use of science for constructive purposes. In an authoritarian society a scientist who does not want his work used for destructive purposes has a negative action available to him of refusing to work on projects he does not approve. In a democratic society the scientist has a greater range of possible action. In addition to the negative action he has a positive action available to him, namely the opportunity to explain the significance of current scientific research to the laymen in order to give the laymen the knowledge needed to vote intelligently on important issues.

I agreed to speak Sunday evening to the S S R S. chapter in Philadelphia meeting at the University of Pennsylvania. I found the meeting very worthwhile to get other people's reactions to my ideas. I used a film-strip on the "Lost Symbols"⁽⁹⁾ to illustrate how specialists in a prior age found ways to explain their specialized knowledge and insights to the layman. During the middle ages only a small percentage of the people could read and write. The priests developed art forms such as stained glass windows and carvings to illustrate their sermons in a way that conveyed meaning to people who couldn't read. In many of the old cathedrals each section of a stained glass window represented a sermon. Many of the symbols were described in the "Bestiary" which was a book "natural science" and moral and religious teachings. For example, the sly fox was used to indicate how wary we must be of falling into temptation. The dove was used to illustrate the sermon theme: Christians are to be harmless as doves, hurting no one by word or deed. The scientific information (or nature study) contained in these examples was faulty. As man learned more about nature these symbols were discarded. During the period of use of these symbols, they helped emphasize the central ideas of the sermons and acted as reminders to the laymen of the principles given in past sermons.

Why cannot the scientist of today work with artists to develop art forms to illustrate the important points of modern science? The lost symbols are not adequate for today's problems, but they inspire us to contemplate the possibilities of the future. When a specialist such as a scientist is concerned about the application of his work, he assumes a positive responsibility in a democracy of developing ways to explain the significance of his

work to the layman

The role of the scientist changes from solely that of a searcher for the truth to a role implying in addition a responsibility to explain his work to the layman as we enter a new state of the biosphere, namely the "noösphere"⁽¹⁰⁾. The name for this new epoch was coined by W. I. Vernadsky of the Academy of Sciences of the U.S.S.R. from the Greek word "noös" meaning mind, to represent the epoch where man through his intellectual activities is able to make geologically significant changes in the "biosphere", i.e., in the portion of the earth's crust, surface, and atmosphere where life can exist.

As we pass into this new epoch of the geological history of the earth -- the Noösphere, man needs a new perspective to symbolize the fact of man's importance, now he has the power and responsibility to make geologically significant changes on the Earth. What will be the symbols of the new era that will link the myths man believes with the great creative potentialities of this new epoch? Will the symbol of the era be an Elvis Presley, a Davy Crockett, or an Albert Schweitzer? Or will some new symbols of man's knowledge of himself and of nature be created? To open up discussion of these potential symbols I presented a series of slides illustrating potential symbols such as the logarithmic increase curve common to many phenomena, symbols representing cybernetics and information theory, great heroes, technological turning points, theoretical developments such as Einstein's special theory of relativity, and the golden plover -- a bird whose navigational ability is not yet understood by science, but which intrigues the mystics.

I feel that decisions as to what is a constructive use of science involve a more complicated analysis than a simple division of projects in military and non-military work. An example of a very significant contribution to basic research supported by military contracts is the work summarized in Essays in the use of Information Theory in Biology⁽¹¹⁾ edited by Henry Quastler.

National Security and Cybernetics

The system of loyalty oaths and security checks covering most governmental jobs needs to be reviewed as to its validity. It seems logical that there are sensitive positions in the Department of Defense, State Department, and other government agencies where specific information must be safeguarded by such security checks. However, it appears that the use of security checks for all government employees and large sections of engineering and manufacturing has (a) disabled the feedback loop system in our society which is needed to make our social system stable and (b) disabled part of the creative ability of our young people through the

atmosphere inhibiting expression of their normal feelings for peace and a better social order which develops during adolescence. Great leaders like Wendell Wilkie had opportunities to sample the politically radical groups that existed in our country during his youth in a way to develop understanding of the economic and political problems of our country.

The prosecution of communist party leaders under the Smith Act may have been a particularly disastrous occurrence for our country. Radical or dissenting political groups are needed in a democracy to provide the feedback loops which act as thermometers to indicate (1) where there are injustices in our social system, and (2) the incidence of psychologically immature people in our society. It may be difficult to determine how much radical political activity is due to inadequacies of the social system and how much is due to psychologically unbalanced people.

The present situation requires that individuals take the responsibility on their own initiative to understand what is going on in our society -- to find out what philosophical ideas are generated by the conditions in our society and what types of psychological problems are accentuated under present conditions. Individuals who seek to understand the problems of our society in a way that re-establishes the necessary feedback loops for stability in our country, have to develop principles like a physician who holds in confidence the problems of his patients. The person who seeks to help stabilize our country must keep in confidence the names of people he interviews, if he is to be free to use their political ideas in analysing our society.

This whole problem of national security and the stability of our nation could probably be reformulated now through the use of Decision Theory⁽¹²⁾. Although we do not have accurate information on the loss matrices for loss of military information through spying and loss matrices for the loss to our society from the crippling of feedback loops, a mathematical model can help direct our research on such problems.

Conclusions

The interchange of ideas between social scientists, political leaders, citizens, engineers, and mathematicians can result in refreshing re-examination of important problems in our society. The layman may have the keenest sense of what the problems are, but may confuse the issue by oversimplification. The social scientists have the detailed knowledge, but need the mathematical and analogical assistance from mathematicians and engineers. This type of work can be done as a hobby by the people concerned during the exploratory stages of developing a greater interchange of ideas across the boundaries of established disciplines.

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12 - 13 - 57

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