

COMMUNICATION THEORY in the CAUSE of MAN

VOL. II NO. 2

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Notes on the application of General Systems Theory, Cybernetics, Information Theory, and related fields of Communication Theory to the strengthening of democratic institutions on our planet.

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This issue of COMMUNICATION THEORY in the CAUSE of MAN is a special issue for presenting a paper on three technical levels in the same document for the First Annual Meeting of the Far West Region of the Society for General Systems Research and the Third Annual Institute of Systems Education (Western Division of the National Task Force on Systems Education of the Society for General Systems Research), Portland, Oregon, September 14-15, 1972.

"A Second Order Approximation to a World System of Nations Based on a Continuous Channel Model from Information Theory."
by Frederick Bernard Wood

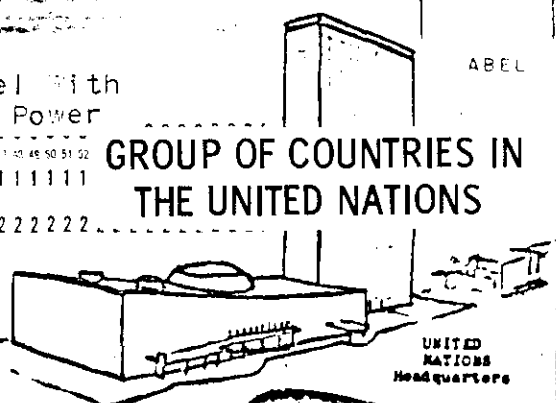
MULTI-CONDUCTOR TELEPHONE CABLE



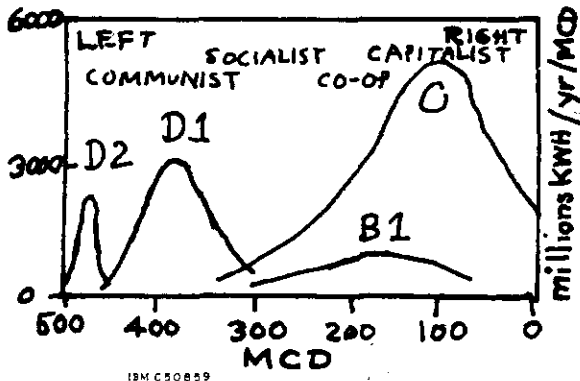
Continuous Channel with Limited Average Power

ABEL

GROUP OF COUNTRIES IN THE UNITED NATIONS



SHARE 709 SYMBOLIC CARD



Y-axis: millions KWH/yr/MCD (0 to 6000)
X-axis: MCD (500 to 0)

Curves: D2, D1, B1, C

Labels: LEFT COMMUNIST, SOCIALIST CO-OP, RIGHT CAPITALIST

$$H_x = - \int p(x) \log p(x) dx.$$

$$p(x) = \left[\frac{1}{(2\pi)^{1/2}} \right] e^{-x^2/2\sigma^2}$$

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IBM C50859

C O N T E N T S O F T H I S I S S U E

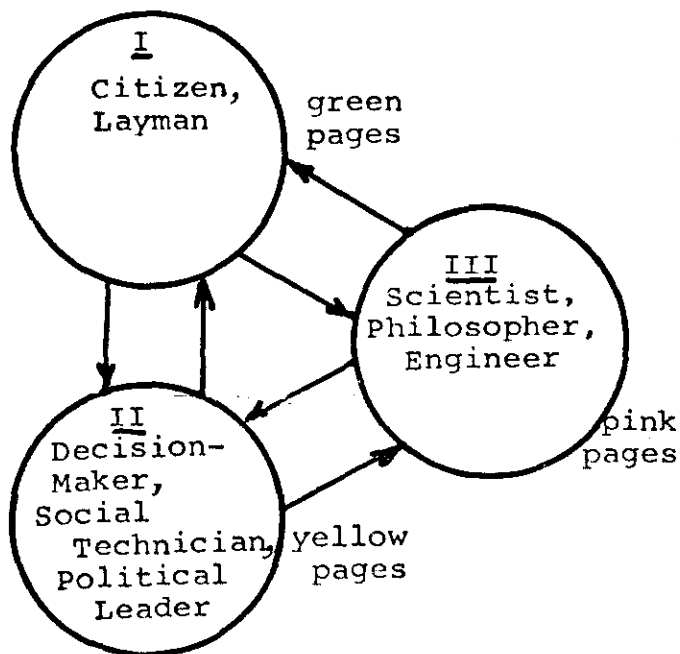
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NOTE ON REVISIONS AND ADDITIONS TO CTCM:

- '7' in File No. 100-F-7 indicates updating to August 30, 1970.
- '10' in File No. 98-F-10 indicates updating to March 28, 1971.
- '14' in File No. 97-F-14 indicates updating to March 5, 1972.
- '15' in File No. 97-F-15 indicates updating to June 18, 1972.
- '16' in File No. 97-F-16 indicates updating to July 16, 1972

To explain why I am including three levels of complexity in one document, I am reprinting my statement from CTCM, Vol. I, No. 12:

This issue of COMMUNICATION THEORY in the CAUSE of MAN has been delayed a number of months, while the editor was trying a number of alternatives for presenting material on three levels of complexity together in the same issue. The problem stems from the question of who is going to benefit from research in General Systems Theory, Cybernetics, and Information Theory. Are these fields of science and engineering going to be used for the benefit of all mankind? Or are they going to be used primarily for the private benefit of particular ruling classes? How do we insure the use of such knowledge in the interests of strengthening democratic institutions? I have an intuitive feeling that to protect the interests of the people, some way must be found to combine general articles, technical applications articles, and basic scientific articles into the same journals and books, while maintaining proper labels as to the nature of the different sections. The three groups of readers are illustrated by the following diagram:



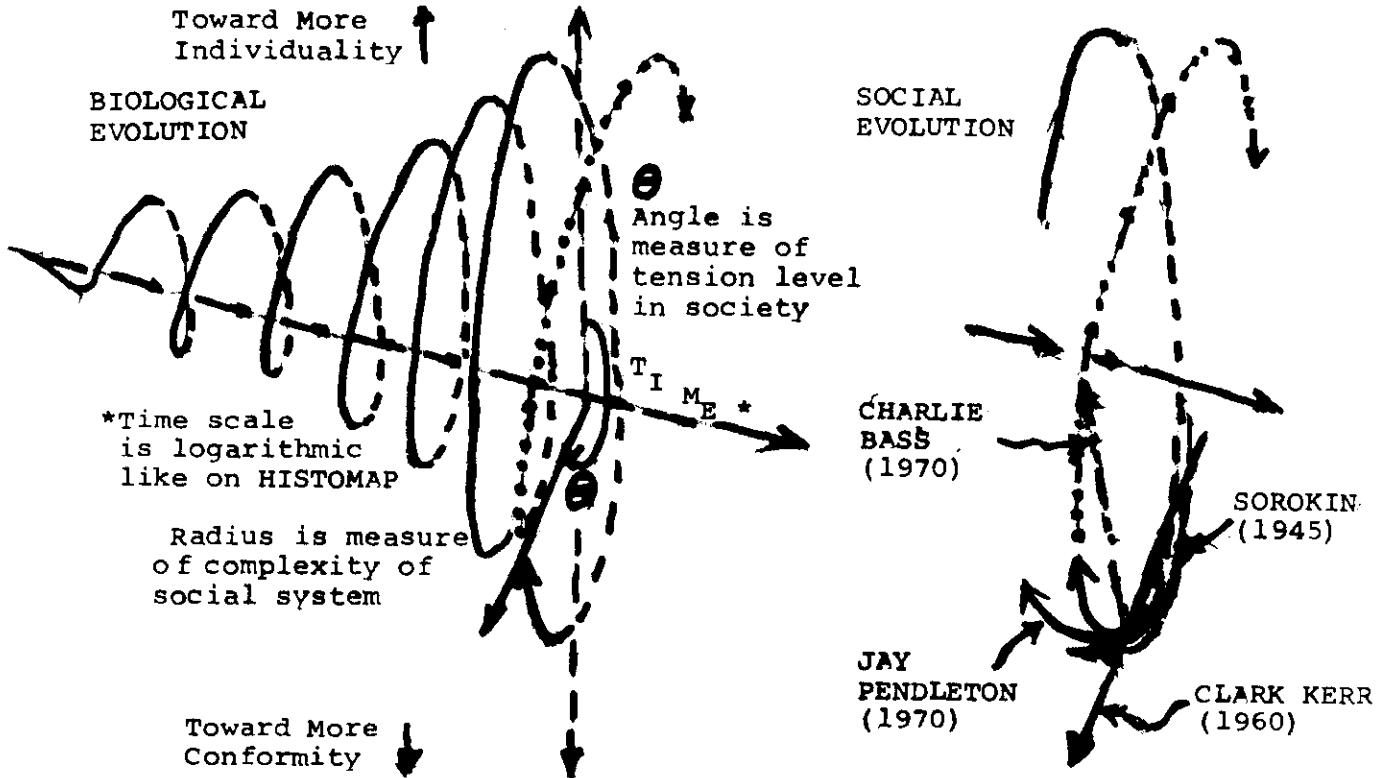
This issue of CTCM represents a partial conversion to the new organization. It will probably take two or three issues to fully implement this concept of separating the three types of material into the green, yellow and pink sections.

EDITORIAL NOTES:

The first or prime question on which this series is based is the survival of human civilization on the planet Earth. The second question is about the quality of human life on this crowded planet. To get at these questions I shall make hypotheses on the basis of the process of "technological meditation," which will have to be tested, and verified, modified, or rejected when the evidence is collected.

I make two basic hypotheses in regard to the survival of human civilization:

CRITICAL PATH OF EVOLUTION (I) There is some critical path about which the evolution of human civilization must stay close or else the present leading countries will collapse, leaving the evolution of civilization to be carried on by some other culture.



COLLAPSING COUNTRY CAN DESTROY LIFE BY RADIATION (II) The problem is compounded in that the major countries can destroy human life on this planet in the process of their societies collapsing. This means that we cannot be satisfied with letting a major power collapse like the disintegration of ancient Rome. A collapsing civilization must either be brought down gently or transformed to get it on the critical path of successful evolution to the next stage of more human organization. Since the development of atomic fission bombs and hydrogen fusion bombs, a collapsing major country could trigger a nuclear war that could contaminate the biosphere with sufficient radioactivity to destroy human life on this planet.

Then I add two hypotheses on how we can solve these problems:

HOMEOSTATIC CYBERNETIC FEEDBACK LOOP SIMULATION (III) The most fundamental approach to understanding the social problems of the world is the cybernetics feedback loop or homeostatic approach. This approach will gradually be extended by various simulation techniques using computers as a prime tool. This approach has some drawbacks in that many of the human factors are difficult to simulate in a formal way, so that there is danger that simulations may omit important factors.

ENTROPY-LIKE PROPERTIES OF SOCIAL SYSTEMS (IV) There is a complementary method, namely that of estimating the values of entropy-like properties of the social systems. These techniques may give fuzzy answers, but will tell us whether we are going in the right direction. Attempting to define entropy-like properties of social systems brings into focus the necessity for equivalent completeness theorems which remind us not to forget the more subtle human factors.

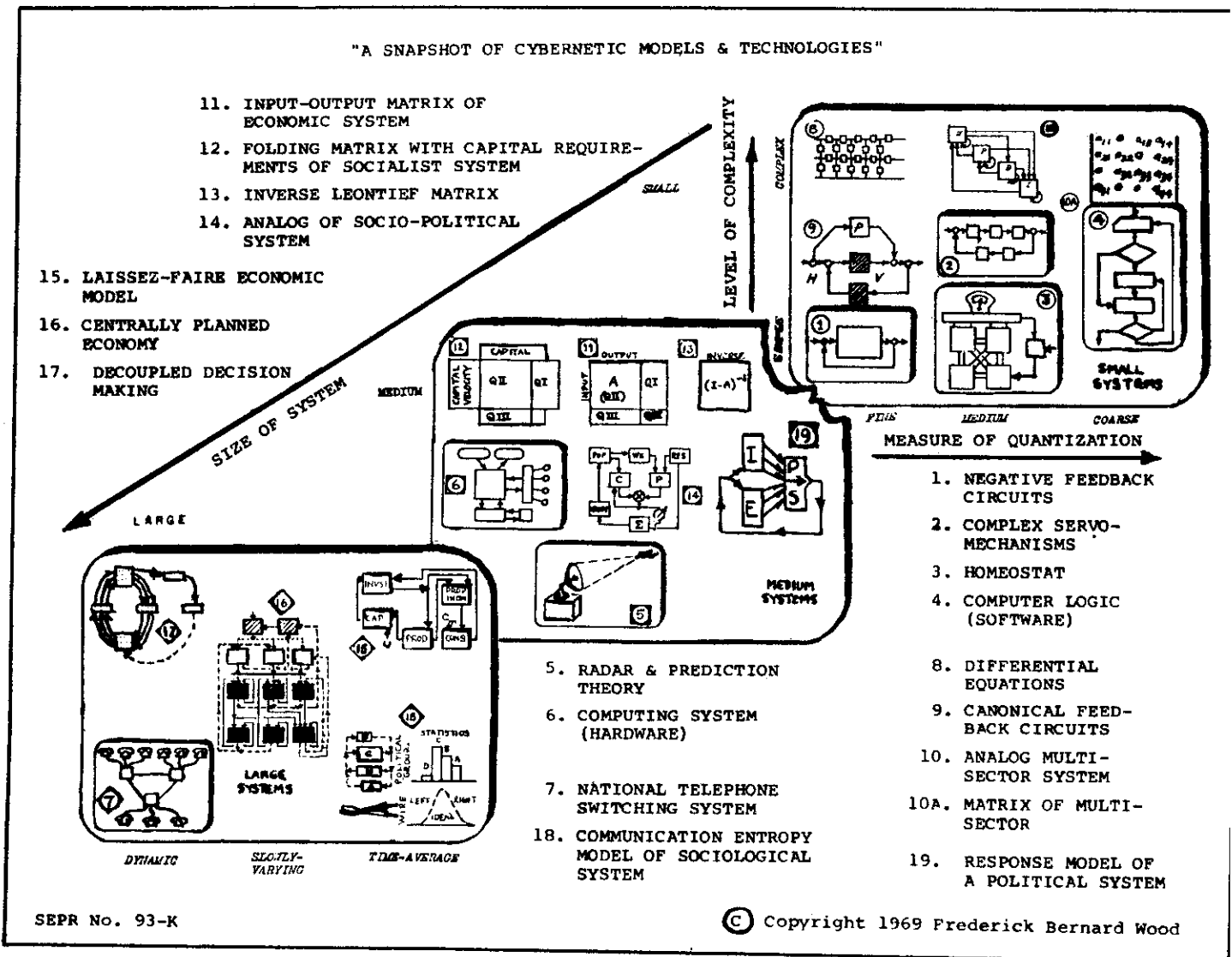
Applying Cybernetics To Maintain Social Balance Between Freedom And Stability

A Snapshot of Cybernetic Models & Technologies

by FREDERICK B. WOOD, PH.D.
EDITOR'S NOTE: The following is the first of a three-part series on applying the concepts of Cybernetics to attack the major problem of maintaining a balance between freedom and stability in human civilization. The views presented are those of the author in his role as a Cybernetics Consultant.

Reprinted from

THE HARBUS NEWS THURSDAY, MARCH 6, 1969



Arnold Toynbee in his **STUDY OF HISTORY** has shown that all great civilizations of the past have gone through a process of developing to great heights and then a period of disintegration. Ours is the first civilization to have the knowledge giving us the capability of preventing the disintegration of our civilization. However, we have not developed a way to use this knowledge to decisively attack the crises of our civilization.

In this series of three short notes, I aim to indicate the direction we can go in applying the concepts of Cybernetics to attack the major problem of maintaining a balance between freedom and stability in human civilization. Let us first examine the dictionary definition of "Cybernetics:"

"Comparative study of the automatic control system formed by the nervous system and the brain and by mechanical - electrical communication systems."

NORBERT WIENER

Norbert Wiener envisioned a much broader definition. J. R. Pierce in **SYMBOLS, SIGNALS AND NOISE** (1962) discusses the problem:

"What is cybernetics? If we are to judge Wiener's book, it includes at least information theory, with which we are now reasonably familiar; something that might be called smoothing, filtering, detection and prediction theory, which deals with finding the presence of and predicting the future value of signals, and usually in the presence of noise; and negative feedback and servomechanisms theory.

We must, I think, also include another field which may be described as automata and complicated machines. This

includes the design and programming of digital machines.

Finally, we must include any phenomena of life which resemble anything in this list or which embody similar processes. This brings to mind at once certain behavioral and regulatory functions of the body, but Wiener goes much further. In his second autobiographical volume, **I AM A MATHEMATICIAN**, he says that sociology and anthropology are primarily sciences of communication and therefore fall under the general head of cybernetics, and he includes, as a special branch of sociology, economics as well."

SCOPE OF CYBERNETICS

I admire Norbert Wiener's vision of the scope of Cybernetics, but I think some practical restrictions are in order. Instead of classifying all social sciences as branches of Cybernetics, I perceive Cybernetics as an applied or engineering type of discipline which provides the common concepts and philosophy with which to integrate the pieces of the different physical and social sciences needed in organizing the evolutionary changes in society that are needed for our civilization to survive in a way that maintains respect for each individual human being.

In this short note I present a snapshot of the major models and technologies of Cybernetics without explanation, leaving it up to the curious reader to explore the references. In the next article, I plan to discuss how cybernetics can be used to coordinate the three methods: humanist - intuitive - poetic; abstract - mathematical - philosophical; and empirical - scientific in their application to aiding social evolution.

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This note is based on a paper presented at the Conference on 'Cybernetics and Society' held at Georgetown University, Washington, D.D., November 19-20, 1964.

THE HARBUS NEWS, THURSDAY, MARCH 13, 1969

The Use Of Cybernetics To Help Connect Decision Processes With Ethical Values

by FREDERICK B. WOOD, PH.D.
EDITOR'S NOTE: The following is the second of a three-part series on applying the concepts of Cybernetics to attack the major problem of maintaining a balance between freedom and stability in human civilization. The views presented are those of the author in his role as a Cybernetics Consultant.

In this second note in a series of three on Cybernetics, I shall discuss the general relationship of Cybernetics to social problems. In the book *THE SOCIAL IMPACT OF CYBERNETICS* (Univ. of Notre Dame, 1966) edited by Charles R. Dechert, there is an important statement on page 189:

"For example, Lindsay and Margenau have formulated an ethical principle based upon the concepts of thermodynamics and Kant's categorical imperative. This principle, called the "thermodynamic imperative," may constitute the principal ethical implication of cybernetics."

Let us examine Professor Margenau's statement of this principle in his book *ETHICS & SCIENCE* (Princeton, 1964), page 83:

"The success of maximum and minimum principles in mathematical physics has induced many similar formulations in ethics -- one wishes to maximize pleasure, freedom, responsibility; minimize pain, poverty, disease. One of the most recent suggestions in this vein, particularly noteworthy because of its specificity and boldness, is contained in R. Bruce Lindsay's thermodynamic imperative, which claims that man, in his ethical behavior, should counteract the natural tendency inherent in the second law of thermodynamics and endeavor to reduce entropy in the environment."

Unfortunately neither Lindsay nor Margenau tell us how to apply the thermodynamic imperative to real cases. Now I shall give you a glimpse of how cybernetics can provide a connection between traditional ethics, the thermodynamic imperative, and a number of other economic and political factors to enable people to measure the probable impact of their decisions on their ethical ideals. In the third note in this series, I shall illustrate this procedure by a specific example.

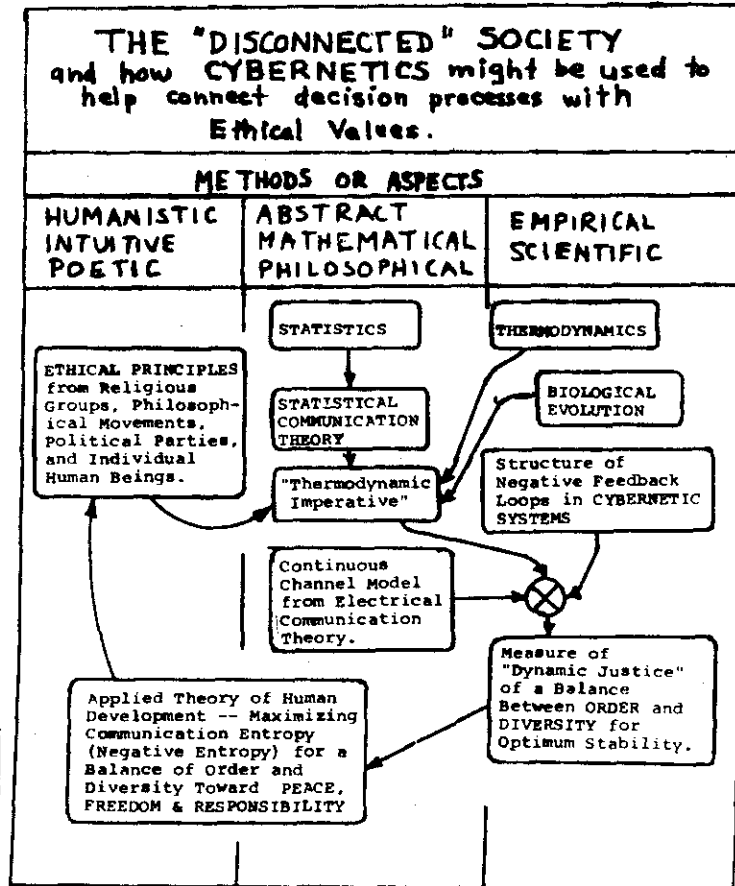
RELIGIOUS FAITHS
If we examine the major re-

ligious faiths of the world, we can find a striking similarity in some of the principal teachings, for example:

BUDDHISM: "Hurt not others with that which pains yourself."
UDANAVARGA, 5, 18.

CHRISTIANITY: "All things whatsoever ye would that men should do to you, the law and the prophets."
ST. MATTHEW 7, 12.

HINDUISM: "This is the sum of duty: do naught to others which, if done to thee, would cause pain."
MAHABHRATA, 5, 1517.



ISLAM: "No one of you is a believer until he loves for his brother what he loves for himself."

TRADITIONS.

JUDAISM: "What is hurtful to yourself do not to your fellow man. That is the whole of the Torah and the remainder is but commentary."

TALMUD.

EXISTENTIAL PHILOSOPHY: Man exists in a tragic unpredictable world in which he must learn to make an authentic - intuitive - creative - unique response to each situation as it develops --- and so attain freedom and responsibility.

Further we find that in some parts of the world, political parties rather than organized religion promulgate ethical principles:

SOVIET UNION: "Communist morality takes the position that only that which contributes to the abolition of human exploitation, poverty, and degradation, and to the building and strengthening of a system of social life from which such inhuman phenomena will be absent is moral and ethical." trans. from Russian SHORT PHILOSOPHIC DICTIONARY.

Now we can see from the above principles that if any two people of different faiths, such as a Christian and a Moslem or a Buddhist and a Communist or an Existentialist and a Jew were to meet face-to-face, they could work out a reasonable agreement on what is ethical in any specific problem under their direct control. Now a major problem on our planet is that these people do not ordinarily meet face-to-face, but they communicate through bureaucratic church, state, party, or corporate organizations. By comparison with cybernetic feedback concepts, we note that there are insufficient

communication feedback loops in the way society is organized for the individual to tell immediately whether a decision he has to make will go with or against his ideals. We have a "disconnected" society in which people are disconnected from the communication and control channels of society.

CHRISTIAN - CAPITALIST

A young Christian - capitalist may work politically to get his government to make economic reforms to help reduce unemployment and, to his surprise, find that these changes disturb some fine balance in the general system and lead to an escalation of war in a far-off country. He is upset because he cannot determine what decision will lead to results consistent with his Christian ethics.

Similarly, a young communist may organize economic reforms in his country to reduce poverty and find that in connection with his reforms, the bureaucracy sends people who don't understand his beautiful plans to prison camps. Here he is upset because his attempt to live up to his ideals of communist morality in abolishing poverty leads to a contradiction -- namely a degradation of some people in the system -- in violation of his communist morality.

DISCONNECTED SOCIETY

All over the world sensitive people are baffled, angry, resigned, or rebellious over living in a disconnected society. They are hurt because they have lost the means of finding a connection between their ideals and the choices society makes available to them.

Now Cybernetics isn't going to generate any new ethical principles. Cybernetics can be used as a tool to establish a reasonable connection between an individual's ethical ideals and the socio-political systems that exist today. A glimpse of how this might be done is illustrated in the diagram.

There are three aspects of the problems of human civilization with their associated methods of analysis, namely the humanistic - intuitive - poetic; abstract - mathematical - philosophical; and the empirical - scientific methods. This "Thermodynamic Imperative" is a working hypothesis that has the form from statistics and statistical communication theory and is consistent with concepts from thermodynamics and biological evolution. To use this hypothesis we have to know something about the feedback loops in the social system and something about the efficiency of the sets of messages transmitted through the system. This requires us to utilize many of the nineteen cybernetic models and technologies described in last week's article to help us piece together a better understanding of the social-political system.

TEST ALTERNATIVES

Then we can test different alternatives in terms of the thermodynamic imperative on the basis of empirical - scientific methods, provided the tentative conclusions are brought to the ethical principles in the humanistic - intuitive - poetic column for checking by people who dare to express their feelings for or against the trial results. If the trial results are doubtful, we must make a second pass through the loop with a finer detail in the structure of the feedback loops considered and in the message distribution examined.

Thus we see the possibility of our testing proposed decisions against our ethical ideals with increasing confidence as we cycle through more loops of developing appropriate cybernetic systems models. In the third and concluding note in this series, I shall take an elementary problem through one cycle of the loop.

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Approximation To A Cybernetics Systems Interpretation Of A Two Nation System

by FREDERICK BERNARD
WOOD, PH.D.

EDITOR'S NOTE: The following is the third and concluding note of a three-part series on applying the concepts of Cybernetics to attack the major problem of maintaining a balance between freedom and stability in human civilization. The views presented are those of the author in his role as a Cybernetics Consultant.

In this third and concluding note on the application of cybernetics to social problems, I shall consider the problem of a world in which two large powerful countries are predominant. Country K has a Christian - capitalist background, while country J has a socialist orientation under the leadership of the Communist Party. Our problem is to explore

how we can use cybernetics to help the younger generation of capitalist and communist leaders live up to their respective ethical ideals. Since both countries are to some extent disconnected societies in the sense discussed in the second article in this series, our first priority is to find ways to connect the consequences of alternative decisions with the appropriate ethical standards.

Reviewing the chart in the second article in this series, we note that to apply the "thermodynamic imperative," we have to find appropriate parameters of the social system to measure. Lindsay and Margenau state the "thermodynamic imperative" in

terms of decreasing entropy. A number of entropy - like characteristics of systems have been defined. Leon Brillouin in SCIENCE AND INFORMATION THEORY (N.Y., second edition, 1962)

uses the word "negentropy" to denote a property similar to entropy, but negative in sign. To follow the "thermodynamic imperative," we would maximize the negentropy. R.M. Fane uses the word "communication entropy" and C. Shannon used the word "entropy" in the same sense that Brillouin uses the word "negentropy." With this confusion as to sign convention, we have to check our concepts carefully.

FIRST APPROXIMATION

For a first approximation, let us consider each country can be represented by a set of messages being sent over a telegraph line. This is equivalent to using the model #18 from the first note in this series (I) to implement the continuous channel model shown in the abstract - mathematical - philosophical column in the illustration in the second note in this series (II). Now we are going to test ways in which a young Christian leader in a capitalist society can test his decision set against his Christian ideals and how a young communist leader in a socialist society can test a set of alternative decisions against his ideals of communist morality.

We are assuming that application of the thermodynamic imperative to a systems model will give some indication of what conditions will be more likely to facilitate a decision consistent

with ethical principles. If we look in SYSTEM ENGINEERING HANDBOOK (N.Y., 1965) edited by Robert E. Machol, we find a section on "Entropy Maximization" in which Fakhollah M. Reza summarizes the principal cases developed by Shannon. These distributions are shown graphically as curves A, B, & C in the figure below.

So far no rigorous way of determining which limits apply to a given social system has been developed. Therefore we have to utilize the best fragments of knowledge we have, coordinated with intuitive, philosophical, and scientific methods, to develop a hypothesis. Present fragmentary information indicates that distribution A relates more closely to major parameters in the force era (force transmission devices predominate in the technology), distribution B corresponds to the power era (power transmission or power amplifying devices predominate), and distribution C to the communication era (information transmitting or intelligence amplifying systems becoming the dominant technology.)

NORMAL - PROBABILITY

This indicates that for our problem the normal - probability distribution represents the optimum. Even though we are well into the communication era, there are some characteristics of our social systems which still have to be treated in terms of the previous power era, and even some still are characteristic of the force era. For example, we could analyze the status of civil rights in the different states by use of a communication channel model with the finite limits (uniform distribution) criterion. This would give us valuable information on the degree to which the states are living up to our ideals in regard to civil rights, but would tell us nothing about the stability of the United States.

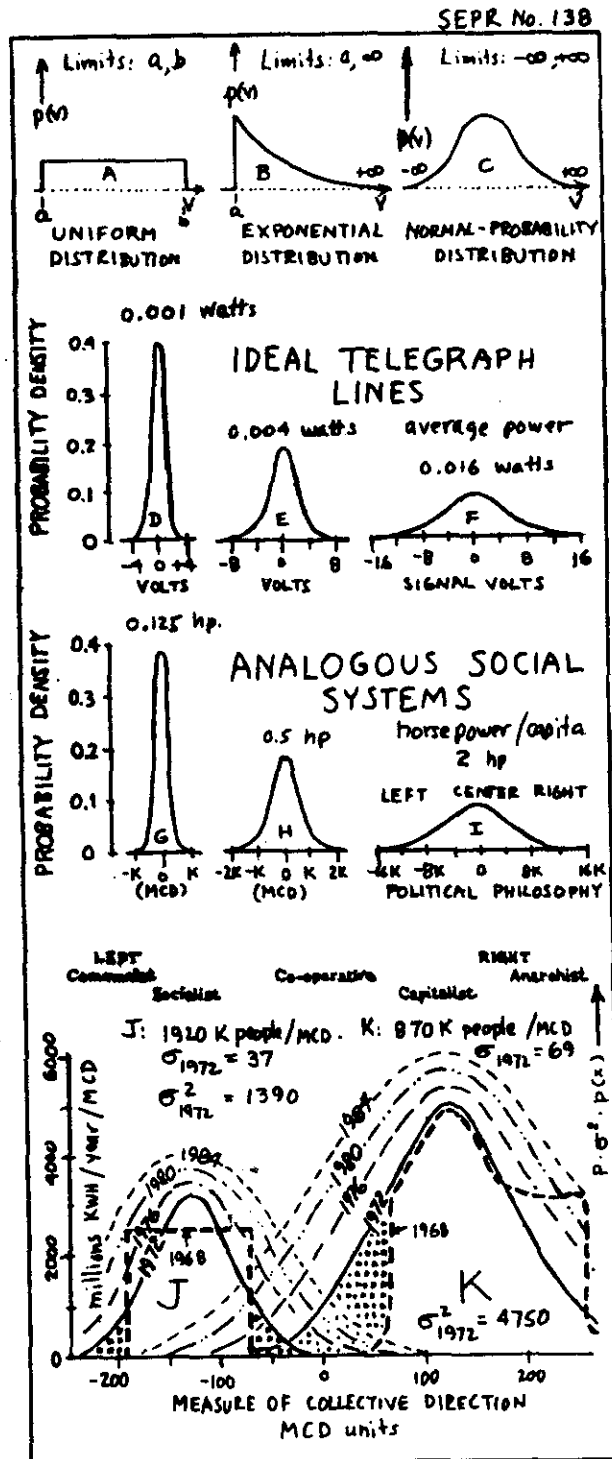
Let us consider an idealized telegraph line on which the voltage is allowed to range from minus infinity to plus infinity. In reality a telephone and telegraph company would not allow this. They limit the voltage to a value less than plus or minus one volt to protect their equipment from damage by high voltage and to reduce interference between adjacent circuits. However, this unrealistic telegraph line can help us define some parameters of a social system which is considered to have a

range of different political ideas which run from the far left (Communist or almost minus infinity) to the far right (possibly anarchist at plus infinity). Curves D, E, & F are the probability distributions of voltage on three such telegraph lines with different average power levels of one milliwatt (0.001 watt), four milliwatts, and sixteen milliwatts, respectively. These curves are computed theoretically by use of the branch of cybernetics known as information theory mentioned in the discussion of the definition of cybernetics in part I of this series.

'THEMATIC HYPOTHESIS'

Now I make a 'thematic hypothesis' in the sense described by Gerald Holton in the chapter "The Thematic Imagination in Science" in SCIENCE & CULTURE (Boston, 1967). This hypothesis is that we can apply certain equations from information theory that were derived for analyzing the sets of signals on telegraph lines to limited properties of social systems by considering the set of different philosophical or political ideas generated in a social system as equivalent to a set of messages sent over a telegraph system. To meet the tests of science, we must specify how to test any hypothesis we plan to use. In this short note I can only indicate the direction. I am using a procedure similar to that discussed relating to testing of the validity of the special theory of relativity in Wolfgang K.H. Panofsky and Melba Phillips, CLASSICAL ELECTRICITY AND MAGNETISM (Reading, Mass, 1962).

In accordance with my working hypothesis on the application of Lindsay's thermodynamic imperative, I have drawn curves G, H and I for analogous social systems having average power



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per capita of 1/8, 1/2, and 2 horsepower respectively. The probability density indicates the probability of finding people with political views near the points indicated on a scale ranging from far left political views to far right. The curves G, H, & I are optimum distributions of power against the range of political views. Curve G indicates that a country having low energy resources giving only 1/8 hp per capita functions optimally by concentrating almost all effort on a single plan of economic development. Operating at the subsistence level, the system can't afford much divergence of operations in producing its elementary economic needs. Curve H is for a system that has four times the power per capita of the system of curve G. Here we see that by analogy from the telegraph line cases, this social system can function optimally with a larger divergence of political views. Looking at Curve I, we find even a higher diversity of political ideas is required for optimum functioning of the system.

AN INTERNATIONAL SYSTEM

To consider an international system where nations 'J' and 'K' are the two most powerful nations, let us plot curves to the availability of electric power to people on a scale of political ideas. The dashed rectangular curve 'J (1968)' represents the estimated distribution of electrical power to people in socialist country 'J' for the year 1968. Similarly the irregular shaped curve 'K (1968)' represents the distribution of electric power to groups of people of differing political views in capitalist country 'K.'

Now the curves 'J (1972)' and 'K (1972)' represent the ideal distribution of power for coun-

tries J and K, if they succeeded in distributing their power among different political groups in accordance with the thermodynamic imperative. This says that the young communist leader who wishes to live up to his ideals of communist morality can improve the chances of doing so by working to change features of his social system so that greater diversity is tolerated. The optimum changes are indicated in the area between curves 'J (1968)' and 'J (1972).'

Our young communist leader in country J will have to establish face - to - face communication with minorities in their country such as the far-left communists and non-politically oriented consumer co-operatives. Thus the first loop around the path in the chart in part II skipped the structural details of the cybernetic feedback loops, used a communication channel model to connect the thermodynamic imperative to the social problems, which led to pinpointing what minority groups in the country required more human communication to enable the young communist leaders to live up to their ideals.

Likewise in country K, the gap between curve 'K (1972)' and 'K (1968)' indicates the minority groups with which the young christian - capitalist leaders will have to establish face - to - face communications in order to bring the power distribution curve closer to the optimum form. In country K we might have a different scale of political philosophies. The scale of significance might break more on ethnic or racial lines such as Indian, Chicano, Black, Catholic, and WASP.

MAINTAIN PEACE

Now there is an added dividend to the people of the world, if the two major powers move closer to their optimum curves of power distribution. If in addition, the young political leaders of countries J and K use most of the other cybernetic models and technologies shown in the snapshot chart of part I, they can increase their country's economic and cultural growth as indicated by the two sets of curves marked 1972, 1976, 1980, and 1984. They can increase the chances of maintaining a just and honorable peace.

I.e., by 1984 both countries J and K could, from trying to reach their optimum form of power distribution and their economic growth, have developed significant minorities in country K who were prepared to communicate with corresponding people in country J so that both countries would have increased communication with the other country. This could lead to more fundamental international cooperation by countries J and K. We then might have to update Isaiah's "... and men shall beat their swords into plowshares, and their spears into pruning hooks. ..."

to express the idea of utilizing the mathematical and technological concepts used in designing military command, control, and weapons systems to set in motion more fundamental peaceful cooperation of the major countries of the world.

This note is based upon a progress report of the author's Socio - Engineering Problems Reports Philosophy Project made at The First International Congress for Social Psychiatry, London, England, August 17 - 22, 1964. This project is based on Research Proposal GM-11277-01 submitted to National Institutes of Health, U.S. Department of Health, Education and Welfare. The proposal was drafted in October 1962, while the author was on leave of absence from his engineering job.

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The following table on the three eras is reprinted from an earlier issue of CTCM:

TABLE: THE THREE ERAS OF HUMAN CIVILIZATION:
 FORCE, POWER, AND COMMUNICATION.

ERA (time span)	Characteristic of Major Tools of Era	Notes on Social Implications
FORCE 7000 yrs.	Force Amplifying Devices such as levers, pulleys, bows and arrows. Transition: First Industrial Revolution.	Led to the division of labor into agricultural workers, craftsmen, and standing armies. Also the first large cities at major river deltas.
POWER 300 years	Power Amplifying Devices such as the steam engine, electric motor, gasoline engine, diesel engine, atomic bomb, nuclear power generation, and hydrogen bomb. Transition: Second Industrial Revolution.	Led to the abolition of slavery on the basis that use of power amplifiers could produce more than slaves and that educated technicians were needed to maintain the power amplifiers.
COMMUNICATION* 25 years	Intelligence amplifying devices such as RADAR, SONAR, electronic computers, television, automated factories and chemical refineries, and communication satellites.	When half of the cost of an automobile consists of data processing and expediting of parts orders in connection with production control, it is safe to say that we are well into the Communication Era. This communication era gives us the tools with which we could communicate with the Viet Cong, Cubans, Red Chinese, and many others to give people technical assistance in a constructive way without the need for military action. Force could be restricted to U.N. police action the communication era.

* called "Information Era" or "Cybernetic Era" by some philosophers.

The above table is reprinted from CTCM Jan-Feb 1971, Vol. I, No. 7-8, p. 14.

