COMMUNICATION THEORY in the CAUSE of MAN

VOL. II NO. 2

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.

Frederick Bernard Wood, Ph.D., Publisher
   P.O. Box 5095, San Jose, Calif. 95150
                 U.S.A.

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
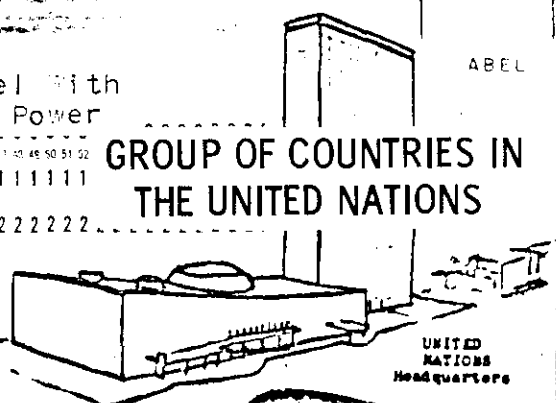

MULTI-CONDUCTOR TELEPHONE CABLE

Continuous Channel With
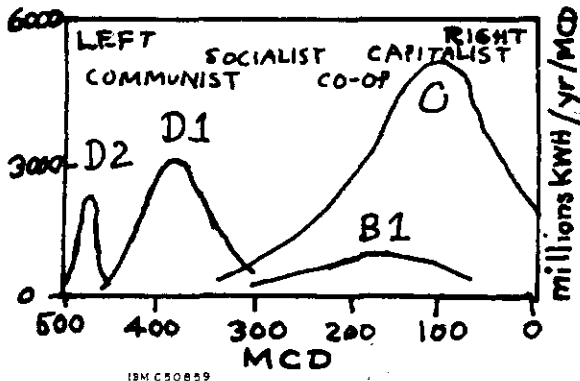Limited Average Power

GROUP OF COUNTRIES IN
THE UNITED NATIONS

LEFT   SOCIALIST   CAPITALIST   RIGHT
COMMUNIST   CO-OP

UNITED
NATIONS
Headquarters

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

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

CONTENTS OF THIS ISSUE

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 parti-
cular 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 illus-
trated by the following diagram:
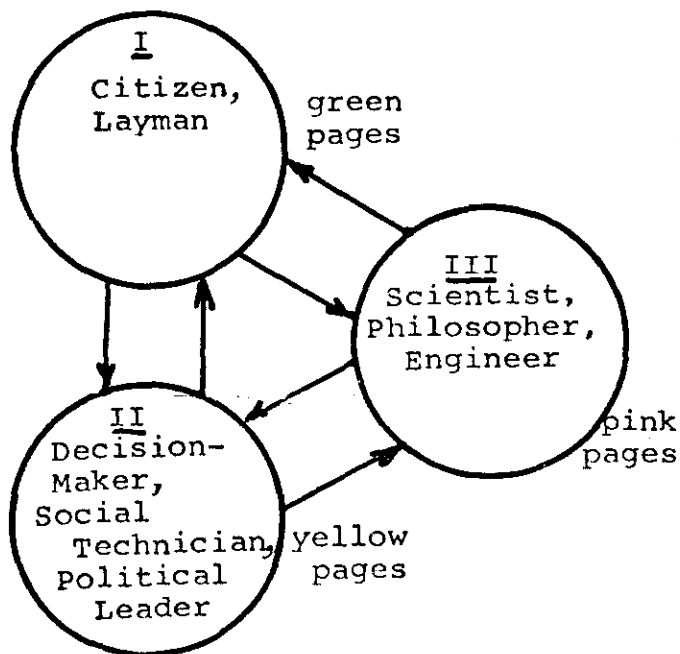
This issue of CTCM represents a
partial conversion to the new
organization. It will probably
take two or three issues to
fully implement this concept of
separating the three types of
material into the green, yellow
and pink sections.

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.

Toward More Individuality ↑

BIOLOGICAL EVOLUTION

SOCIAL EVOLUTION

Angle is measure of tension level in society

$T_{I_{M_E}}$ *

*Time scale is logarithmic like on HISTOMAP

Radius is measure of complexity of social system

CHARLIE BASS (1970)

SOROKIN (1945)

JAY PENDLETON (1970)

CLARK KERR (1960)

Toward More Conformity ↓
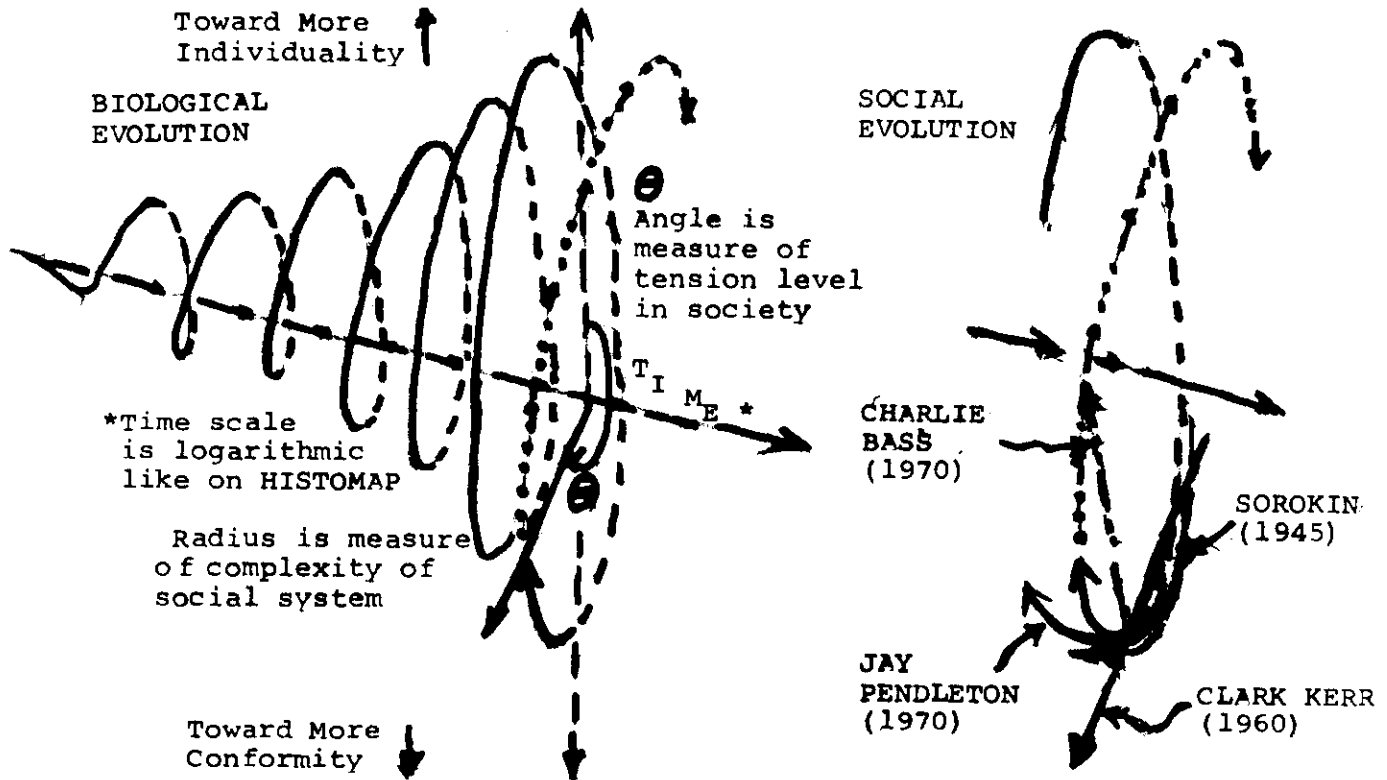
COLLAPSING COUNTRY CAN DESTROY LIFE BY RADIATION

(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.

Section 1.1.6: A Snapshot of
Cybernetic Models and Technologies.

CTCM Vol. II, No. 2, p. 5
File No. 116-F-16   p. 1

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

"A SNAPSHOT OF CYBERNETIC MODELS & TECHNOLOGIES"

11. INPUT-OUTPUT MATRIX OF ECONOMIC SYSTEM

12. FOLDING MATRIX WITH CAPITAL REQUIREMENTS OF SOCIALIST SYSTEM

13. INVERSE LEONTIEF MATRIX

14. ANALOG OF SOCIO-POLITICAL SYSTEM

15. LAISSEZ-FAIRE ECONOMIC MODEL

16. CENTRALLY PLANNED ECONOMY

17. DECOUPLED DECISION MAKING

LEVEL OF COMPLEXITY

SIZE OF SYSTEM

MEASURE OF QUANTIZATION

1. NEGATIVE FEEDBACK CIRCUITS

2. COMPLEX SERVO-MECHANISMS

3. HOMEOSTAT

4. COMPUTER LOGIC (SOFTWARE)

5. RADAR & PREDICTION THEORY

6. COMPUTING SYSTEM (HARDWARE)

7. NATIONAL TELEPHONE SWITCHING SYSTEM

18. COMMUNICATION ENTROPY MODEL OF SOCIOLOGICAL SYSTEM

8. DIFFERENTIAL EQUATIONS

9. CANONICAL FEEDBACK CIRCUITS

10. ANALOG MULTI-SECTOR SYSTEM

10A. MATRIX OF MULTI-SECTOR

19. RESPONSE MODEL OF A POLITICAL SYSTEM

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.

CYBERNETICS BIBLIOGRAPHY
(Numbers keyed to Snapshot Chart)

1. CYBERNETICS by Norbert Wiener, N.Y., 1948.
2. THEORY OF SERVOMECHANISMS, MIT Radiation Lab., Vol. 25, N.Y., 1947.
3. AN INTRODUCTION TO CYBERNETICS by W. Ross Ashby, N.Y., 1956.
4. COMMUNICATIONS OF THE ASSOC. FOR COMPUTING MACHINERY (Magazine.)
5. RADAR SYSTEM ENGINEERING, MIT Radiation Lab., Vol. 1, N.Y., 1947.
6. "Hardware for Purposive Systems," by J.A. Haddad in PURPOSIVE SYSTEMS edited by Heinz von Forester, Washington, 1968.
7. BELL LABORATORIES RECORD (Magazine.)
8. "Stability by Liapunov's Direct Method" in Richard Bellman, editor, MATHEMATICS IN SCIENCE AND ENGINEERING, Vol. 4, N.Y., 1961.
9. THE CONTROL OF MULTIVARIATE SYSTEMS by Mihajlo Mesavoric, MIT, 1960.
10. INTELLIGENT MACHINES by D.A. Bell, N.Y., 1962.
11. INTERINDUSTRY ECONOMICS by Hollis B. Cheney and Paul G. Clark, N.Y., 1959.
12. MULTI-SECTOR ECONOMIC ACCOUNTS by D.L Oparin, N.Y., 1963.
13. STRUCTURE OF THE AMERICAN ECONOMY by Wasily W. Leontief, N.Y., 1951.
14. MATHEMATICAL BIOLOGY OF SOCIAL BEHAVIOR by N. Rahsevsky, Chicago. 1959.
15. THE EVOLVING SOCIETY edited by Alice Mary Hilton, N.Y., 1966.
16. CYBERNETICS WITHOUT MATHEMATICS by Henry Greniewski, London, 1960.
17. LINEAR PROGRAMMING AND EXTENSION by George B. Dantzig, Princeton, 1963.
18. Section on Cybernetics in CAREERS AND THE MBA '69.
19. MODERN SYSTEMS RESEARCH FOR THE BEHAVIORAL SCIENTIST by Walter Buckley, Chicago, 1968.

Section 1.1.7: Use of Cybernetics To
Help Connect Decision Processes With
Ethical Values.

CTCM Vol. II, No. 2, p. 7
File No. 117-F-16   p. 1

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.
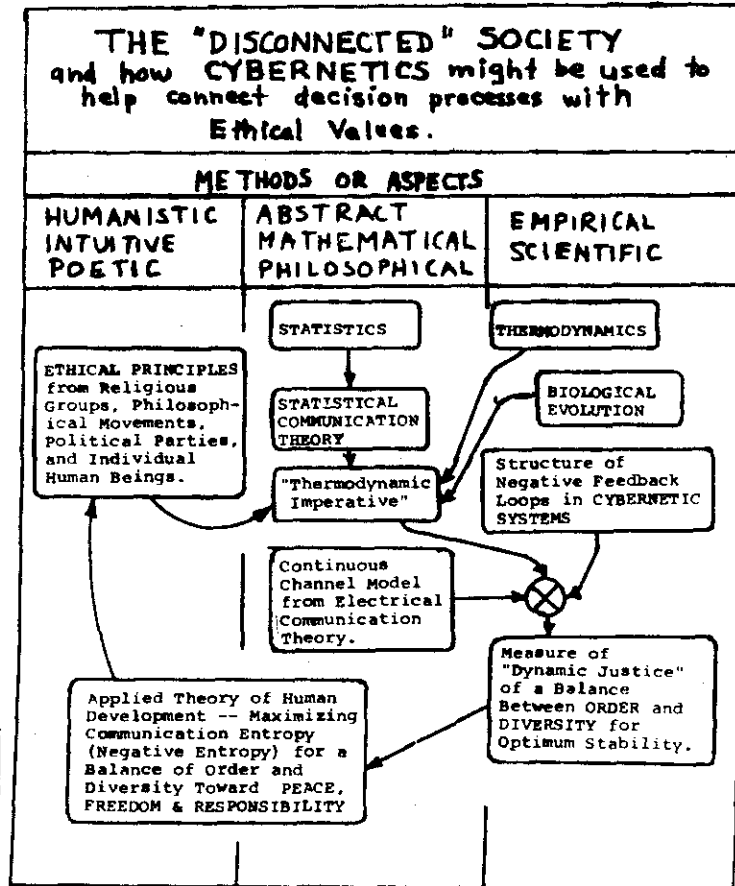
RELIGIOUS FAITHS

If we examine the major religious 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.

THE "DISCONNECTED" SOCIETY and how CYBERNETICS might be used to help connect decision processes with Ethical Values.

METHODS OR ASPECTS

HUMANISTIC INTUITIVE POETIC	ABSTRACT MATHEMATICAL PHILOSOPHICAL	EMPIRICAL SCIENTIFIC

ETHICAL PRINCIPLES from Religious Groups, Philosophical Movements, Political Parties, and Individual Human Beings.

STATISTICS

THERMODYNAMICS

STATISTICAL COMMUNICATION THEORY

BIOLOGICAL EVOLUTION

"Thermodynamic Imperative"

Structure of Negative Feedback Loops in CYBERNETIC SYSTEMS

Continuous Channel Model from Electrical Communication Theory.

Measure of "Dynamic Justice" of a Balance Between ORDER and DIVERSITY for Optimum Stability.

Applied Theory of Human Development -- Maximizing Communication Entropy (Negative Entropy) for a Balance of Order and Diversity Toward PEACE, FREEDOM & RESPONSIBILITY

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 attemtp 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.

Section 1.1.8: Approximation To A
Cybernetics Systems Interpretation
Of A Two Nation System.

CTCM Vol. II, No. 2, p. 9
File No. 118-F-16   p. 1

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 apply-
ing 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 Consul-
tant.

In this third and concluding
note on the application of cyber-
netics to social problems, I shall
consider the problem of a world
in which two large powerful coun-
tries are predom'nant. Country K
has a Christian - capitalist back-
ground, 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 ethi-
cal 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 con-
sequences of alternative de-
cisions with the appropriate eth-
ical standards.

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

terms of decreasing entropy. A
number of entropy - like char-
acteristics of systems have been
defined. Leon Brillouin in SCI-
ENCE AND INFORMATION THE-
ORY (N.Y., second edition, 1962)

uses the word "negentropy" to
denote a property similar to en-
tropy, but negative in sign. To
follow the "thermodynamic im-
perative," we would maximize
the negentropy. R.M. Fane uses
the world "communication en-
tropy" 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 - mathe-
matical - 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 cap-
italist society can test his de-
cision set against his Christian
ideals and how a young com-
munist leader in a socialist so-
ciety can test a set of alternative
decisions against his ideals of
communist morality.

We are assuming that applica-
tion of the thermodynamic im-
perative 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 Maximiza-
tion" in which Faxlollah M. Reza
summarizes the principal cases
developed by Shannon. These dis-
tributions are shown graphically
as curves A, B, & C in the figure
below.

So far no rigorous way of de-
termining 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 fragmen-
tary information indicates that
distribution A relates more
closely to major parameters in
the force era (force transmis-
sion devices predominate in the
technology), distribution B cor-
responds to the power era (pow-
er tramsmission or power am-
plifying devices predominate),
and distribution C to the com-
munication era (information
transmitting or intelligence am-
plifying systems becoming the
dominant technology.)

NORMAL - PROBABILITY

This indicates that for our
problem the normal - probab-
ility 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 chan-
nel model with the finite limits
(uniform distribution) criterion.
This would give us valuable in-
formation 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.

THE HARBUS NEWS THURSDAY, MARCH 27, 1969

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 relatively in Wofgang 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

SEPR No. 138

IDEAL TELEGRAPH LINES

ANALOGOUS SOCIAL SYSTEMS

MEASURE OF COLLECTIVE DIRECTION MCD units
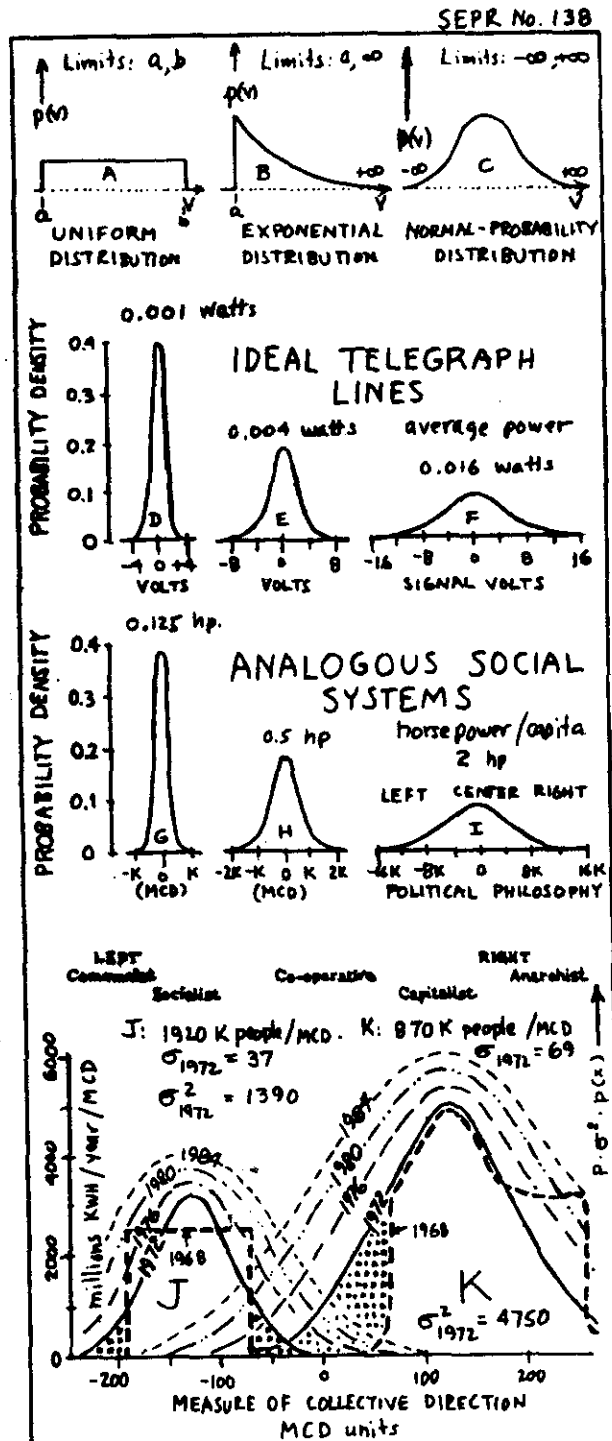
© Copyright 1969 Frederick Bernard Wood

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 co-operation 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.

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 hygrogen 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 satelites.	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.

Section 2.3.4: An Application of the   CTCM Vol. II, No. 2, p. 13
Continuous Channel Model to the   File No. 234-F-16   p. 1
International System of Nations.

This section is adapted from part of a paper presented
at The First International Congress of Social Psychi-
atry, London, United Kingdom, August 17-22, 1964,
"A General Systems Theoretic Model for the Estimation
of the Negentropy of Sociological Systems Through the
Application of Two Isomorphic Electrical Communication
Networks." If I were presenting the same material now,
I would change the title to indicate the relationship
to two communication channel models, namely the discrete
channel and the continuous channel.

Sample numerical calculations of these cases are included
in Section 3.2.2.

A MEASURE OF "DYNAMIC-JUSTICE" BASED ON MAXIMIZING THE NEGENTROPY OF A CONTINUOUS CHANNEL.

The model studied in CTCM Vol. II, No. 1, based upon a pair of electrical wires using the discrete noiseless channel viewpoint from Information Theory gives a good estimate of the negentropy (communication entropy) or "democracy, " but does not give an indication of the country's ability to withstand attack by external and internal enemies. In this section another electrical communication network will be considered that will include a measure of the stability of the social system.

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

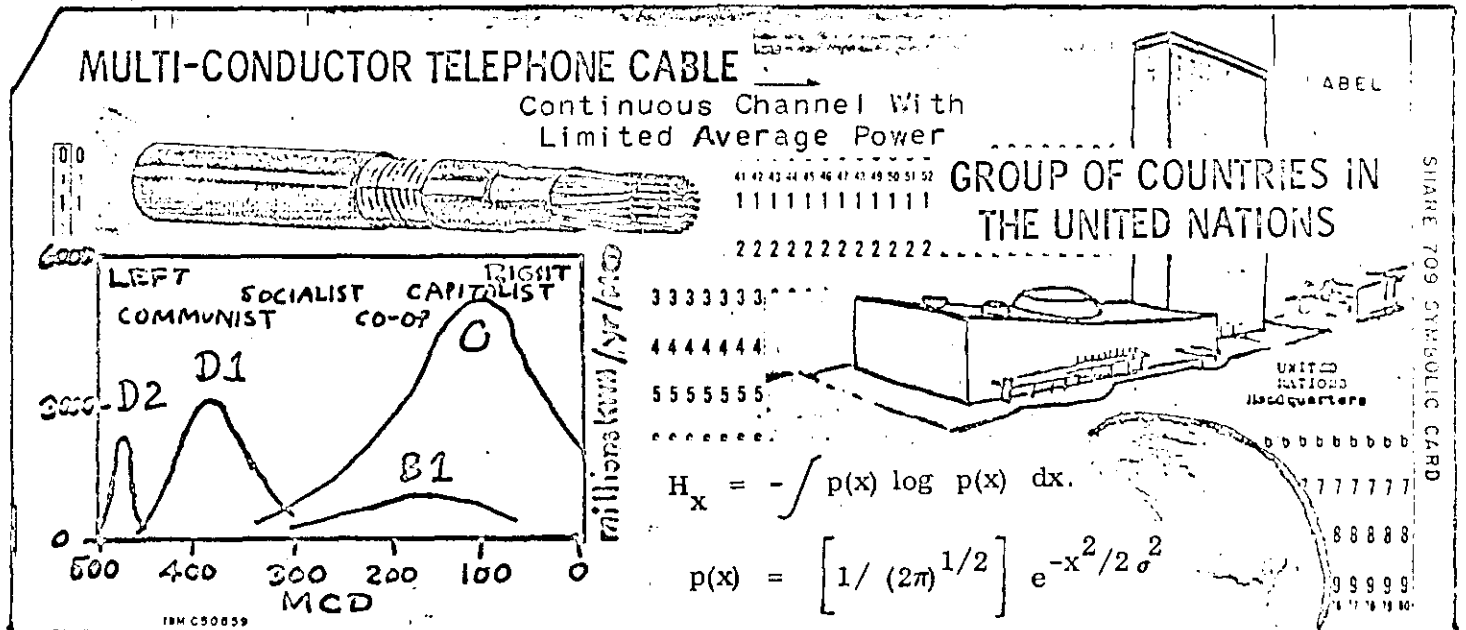$$p(x) = \left[1/ (2\pi)^{1/2} \right] e^{-x^2/2\sigma^2}$$

Fig. 1.   Use of the integral form of the equations for
measuring the communication entropy of telephone signals on
a telephone cable to estimate a measure of "dynamic-justice"
of a country by calculating the negentropy of the distribution
of political ideas tolerated in the country.

The term "dynamic-justice" is proposed for a combination measure of a balance of degree of democracy with organization to withstand external and internal aggression. The telephone cable of Fig. 1   will be used as a model for this analysis by specifying that the power level in each cable pair is limited to a specified average power. The nature of the model from the Information Theoretical viewpoint is that it is a continuous model without noise. To proceed with the analysis we need some measure of the power of the sociological system that will be analogous to the power level in the cable pair. To make trial calculations we shall assume that the electric power production per capita per year is a reasonable first approximation, and that the distribution of political ideas among the population is equivalent to the distribution of signal voltages in the cable pair.

For this assumption, we have from the continuous channel in electrical communication theory, a formula for the entropy, here defined as "negentropy:"

$$H_x = -\int p(x) \, \log \, p(x) \, dx. \qquad [1]$$

For an electrical signal carrying a message on a physical pair of wires, such as any pair in the cable of Fig. 1   , with an average power limited to σ^2, there is a theorem in Information Theory which shows that the negentropy is maximized when the message signal voltage has the following probability distribution:

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

This gives a maximum negentropy of:

$$H_{max} = \log \, (2\pi e)^{1/2} \sigma \qquad [3]$$

For the sociological system, I shall make the following hypothesis:

Hypothesis Two.   The negentropy of the probability distribution of political ideas in a sociological system can be approximated by the negentropy of the message distribution on a telephone cable for the continuous channel with limited average power. The assumed scale of political ideas is taken as a "measure of collective direction" or MCD. The resultant negentropy is considered as a measure of "dynamic-justice" -- a balance between maximizing democracy and maximizing organization to keep the system stable. The telephone cable pair if considered isomorphic to the sociological system, when the limiting average power in the cable is considered equivalent to the per capita power production in the sociological system.

Sample calculations for a set of hypothetical countries are made in **Sec 3.2.2.** Some of the ideal curves for the hypothetical countries are plotted in Fig. 2   The area under the curves is proportional to the annual electric power production of the respective countries.

The important feature of this model is that the "tails" on the probability distribution of political ideas must be preserved in order to maximize the negentropy. Sample curves of distributions departing from the optimum are compared with the optimum in **Sec. 3.2.2.** This type of analysis should help the countries of the world move from policies of "power politics" toward a policy of "human development" in which two countries like Country C and
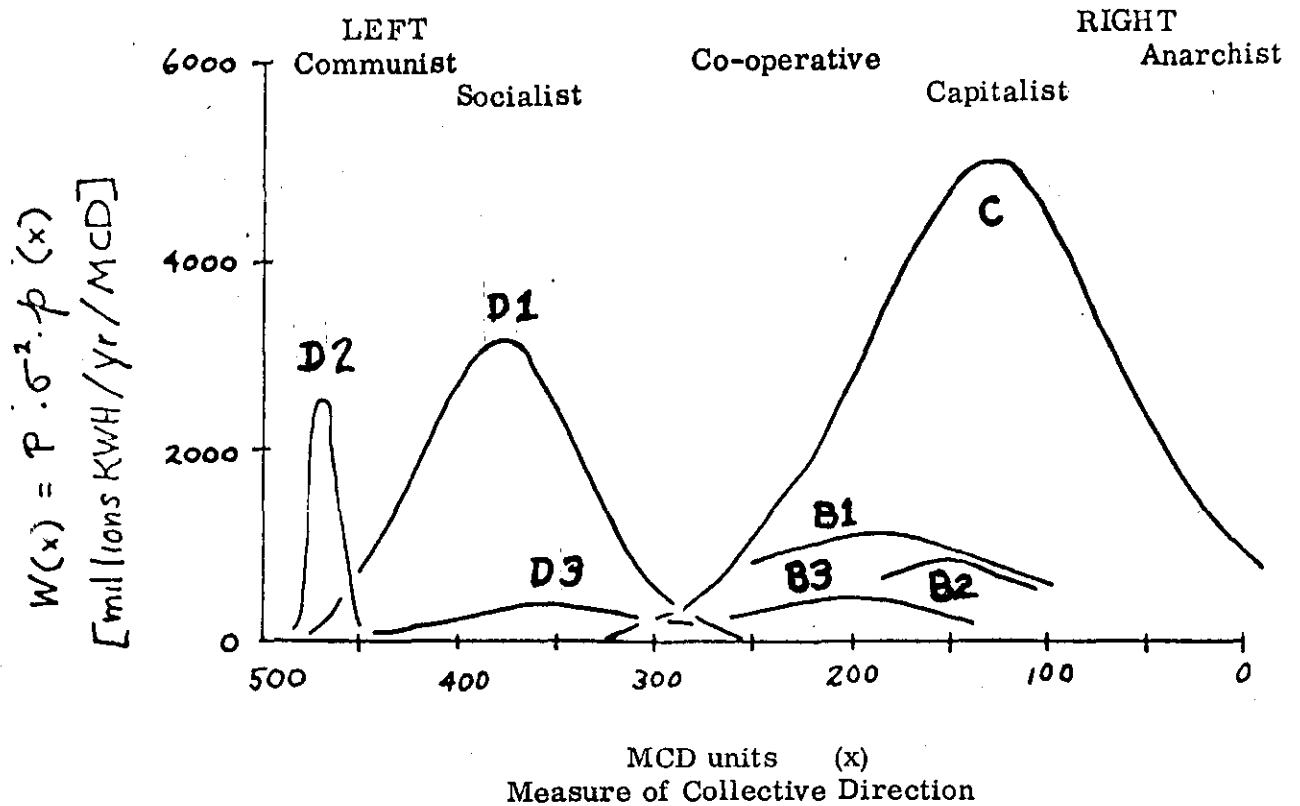
Fig. 2   Ideal Distribution Curves of Power versus Political Ideas for
Some Hypothetical Countries.

Country D1 in Fig. 2 could change from a power struggle between their two ideologies to self and mutual criticsm for not attaining the optimum political ideal distributions appropriate to their respective stages of economic development as measured grossly by their electric power production.

The dotted lines in Fig. 3 show some political idea curves which depart from the ideal shape. Country D1 is operating below its potential for its power level, because it has eliminated the tails on the left and right. Country C's elimination of the left tail and inclusion of the hump on the right make its negentropy depart from its optimum for its stage of development. This type of analysis makes it possible to get a start on determining whether a campaign of "peaceful coexistence" is a bonafide move toward peace or whether it is a propaganda trick. When a country is making progress in coming closer to its optimum curve, it is becoming both more democratic and more stable, so that it may be trusted by the other countries to follow a reasonable stable policy even though there is a large difference in its political ideas compared to its neighbors.

This criterion as to whether a country is approaching its optimum political idea curve should help the psychiatrist in determining the relative balance to put between helping patients adjust to the society and helping patients work to bring their society closer to its optimum distribution.
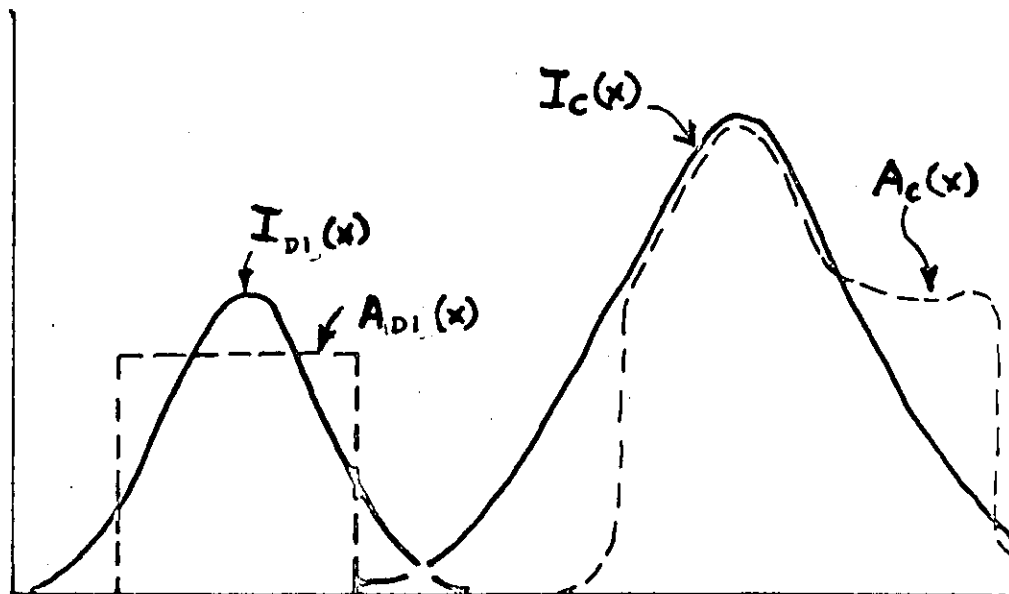
Fig. 3   Examples of Hypothetical Actual Power versus Political Ideas
(A(x) vs. x) Which Depart from Ideal Curves (I(x) vs. x).

Ideal curves of power distribution versus political philosophy
(scale in MCD units) are plotted as solid lines in Fig. 4. for four
different times(1940-1970). So far I have not been able to find any
accurate measure of the real distribution of power. Therefore in the
absence of real data I have plotted some rough guesses as dotted
lines. I hope that some social scientist will dispute the dotted
curves and in the process help us find a way to measure the real
distribution.

THEORETICAL OPTIMUM CURVE

·········· GUESS AT REAL DISTRIBUTION CURVE

1940

$$\sigma^2 = \frac{141 \times 10^9 \, KWH}{131 \times 10^6 \, people} = 1070 \, \frac{KWH}{capita \cdot year}$$

$$\sigma = 32.5$$

$$UNIT \, MCD = \frac{0.34 \times 131 \times 10^6}{32.5} = 1,380 \, K \, people$$

(x-axis: 400, 300, 200, 100, 0) ← X

1950

$$\sigma^2 = \frac{329 \times 10^9 \, KWH}{150.7 \times 10^6 \, people} = 2180 \, \frac{KWH}{capita \cdot year}$$

$$\sigma = 46.8$$

$$UNIT \, MCD = \frac{0.34 \times 150.7 \times 10^6}{46.8} = 1,260 \, K \, people$$

(x-axis: 500, 400, 300, 200, 100, 0) ← X

1960

$$\sigma^2 = \frac{753 \times 10^9 \, KWH}{179 \times 10^6 \, people} = 4,230 \, \frac{KWH}{capita \cdot year}$$

$$\sigma = 65$$

$$UNIT \, MCD = \frac{0.34 \times 179 \times 10^6}{65} = 940 \, K \, people$$

(x-axis: 500, 400, 300, 200, 100, 0) ← X

1970

$$\sigma^2 = \frac{1,529 \times 10^9 \, KWH}{203 \times 10^6 \, people} = 7,550 \, \frac{KWH}{capita \cdot year}$$

$$\sigma = 87$$

$$UNIT \, MCD = \frac{0.34 \times 203 \times 10^6}{87} = 796 \, K \, people$$

(x-axis: 500, 400, 300, 200, 100, 0) ← X   [MCD]

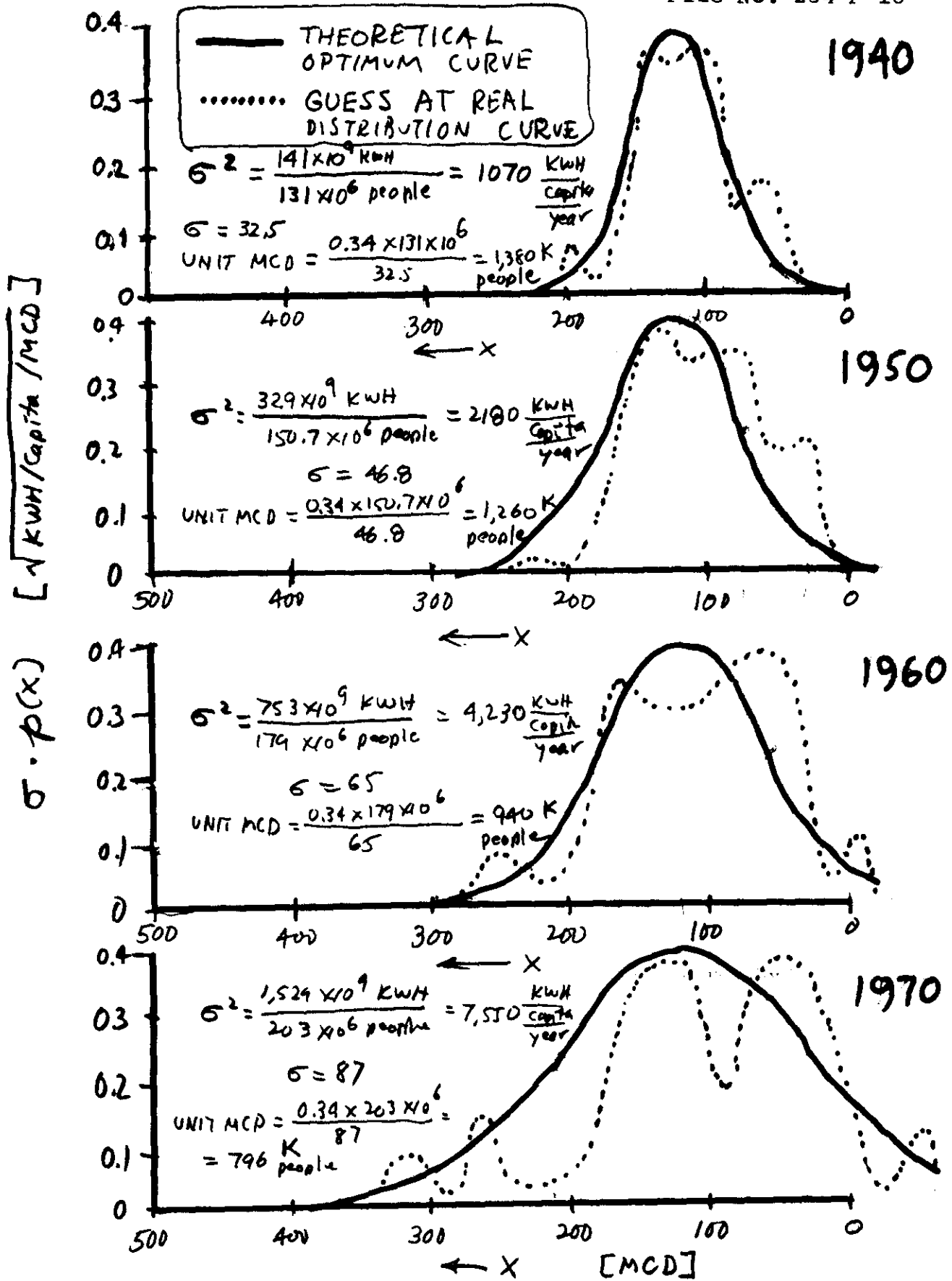y-axis: $\sigma \cdot p(x)$ $[\sqrt{KWH/capita} / MCD]$

Fig. 4. Plots of Ideal Power Distribution for the U.S.A. for the Years: 1940, 1950, 1960, & 1970 (Solid lines) and Estimations of the Actual Distributions (dotted lines).

The parameters used for computing the characteristics of
Countries B1-B6, C, D1-D4, and E1 correspond approximately to
the countries indicated below for data available in the period
1961-1964:

Code Letter	Country
B1	United Kingdom
B2	France
B3	Canada
B4	West Germany
B5	Japan
B6	Sweden
C	U.S.A.
D1	U.S.S.R.
D2	People's Republic of China
D3	German Democratic Republic
D4	Poland
E1	India

Section 3.2.2: Sample Calculations for
the Continuous Channel Model of
Sociological Systems.

CTCM Vol. II, No. 2, p. 19
File No. 322-F-16   p. 1

NEGENTROPY OF THE CONTINUOUS CHANNEL WITH LIMITED POWER
POWER AS A MEASURE OF "DYNAMIC-JUSTICE."

Sample calculations of ideal and non-ideal probability distributions are shown in Fig. 5 The differences in negentropy are indicated for each set on the drawing. The figures used in calculating the ideal curves in Fig. 13 are tabulated in Table A

TABLE A

PARAMETERS OF SOME HYPOTHETICAL COUNTRIES FOR USE IN THE CONTINUOUS CHANNEL MODEL.

Country	Measure of Collective Direction MCD	Population [millions]	Electric Power Prod. [millions K.W.H. /yr]	Elec. Pwr. Per Capita $\sigma 2$ [KWH/cap/yr]	Std. Dev. [σ]	People per MCD unit [thousands]
B1	200	50	137,000	2750	52.5	324
B2	150	45	72,000	1600	40	382
B3	200	17	114,000	6700	81.8	70.6
B4	100	52	116,000	2350	48.5	364
B5	263	92	115,000	1250	35.4	882
B6	200	7	34,000	4900	70	34
C	125	177	840,000	4750	69	870
D1	325	210	292.000	1390	37.3	1,920
D2	463	720	55,000	76	8.7	28,200
D3	350	16	40,000	2500	50	272
D4	375	29	29,000	1000	31.6	313
E1	225	402	20,000	50	7.1	19,400

The different ways of plotting the ideal curves are shown in Fig. 6 . At the top is the universal gaussian probability curve. Ideal curves are plotted for Countries C and D1 in three different ways, namely $p(x)$, $\sigma\, p(x)$, and $\sigma^2 \cdot p(x)$.

Extension of Table A for Country C for a Series of Years.

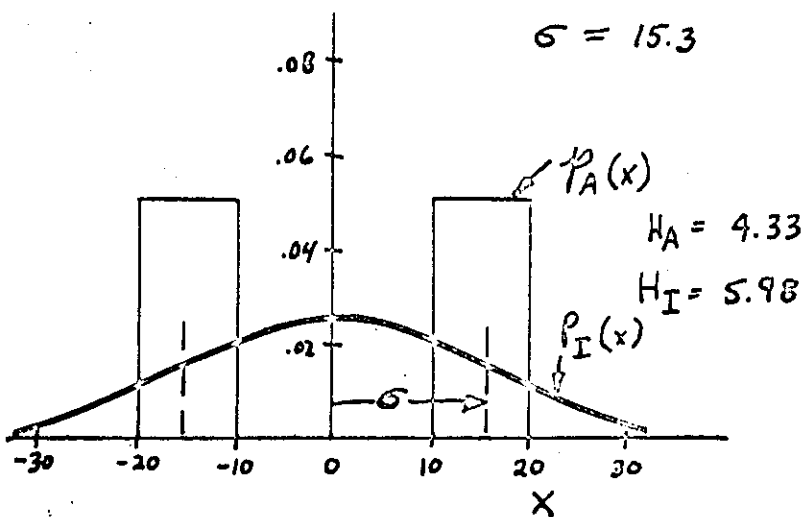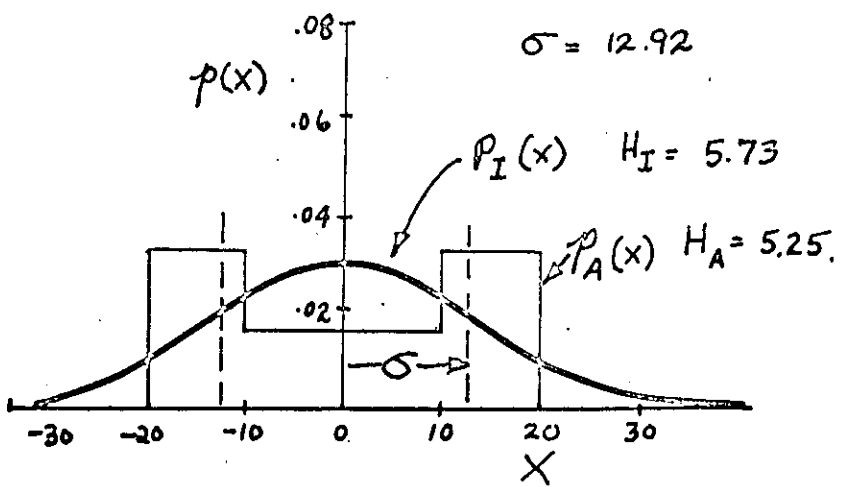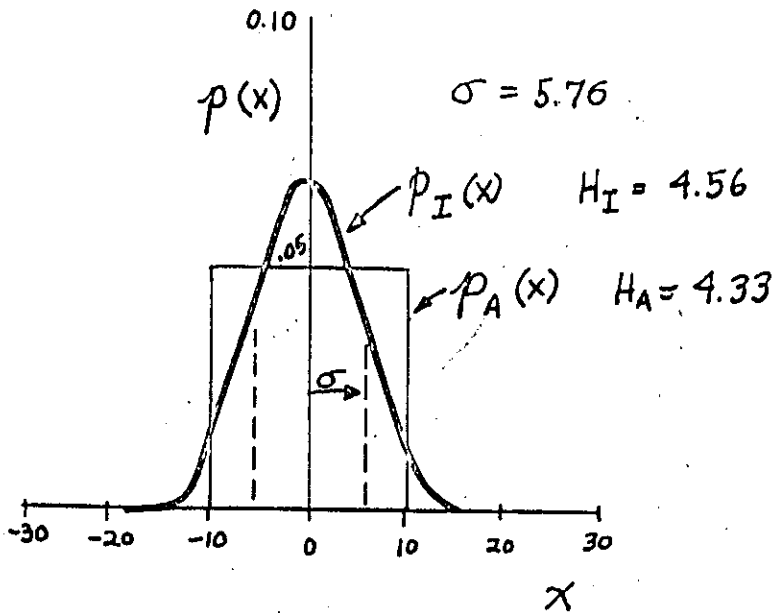|					
C(1940) 120	131	141,000	1070	32.5	1380
C(1950) 120	151	329,000	2180	46.8	1260
C(1960) 120	179	753,000	4230	65	940
C(1970) 120	203	1,529,000	7550	87	796

Fig. 5   Examples of Ideal and Non-Ideal
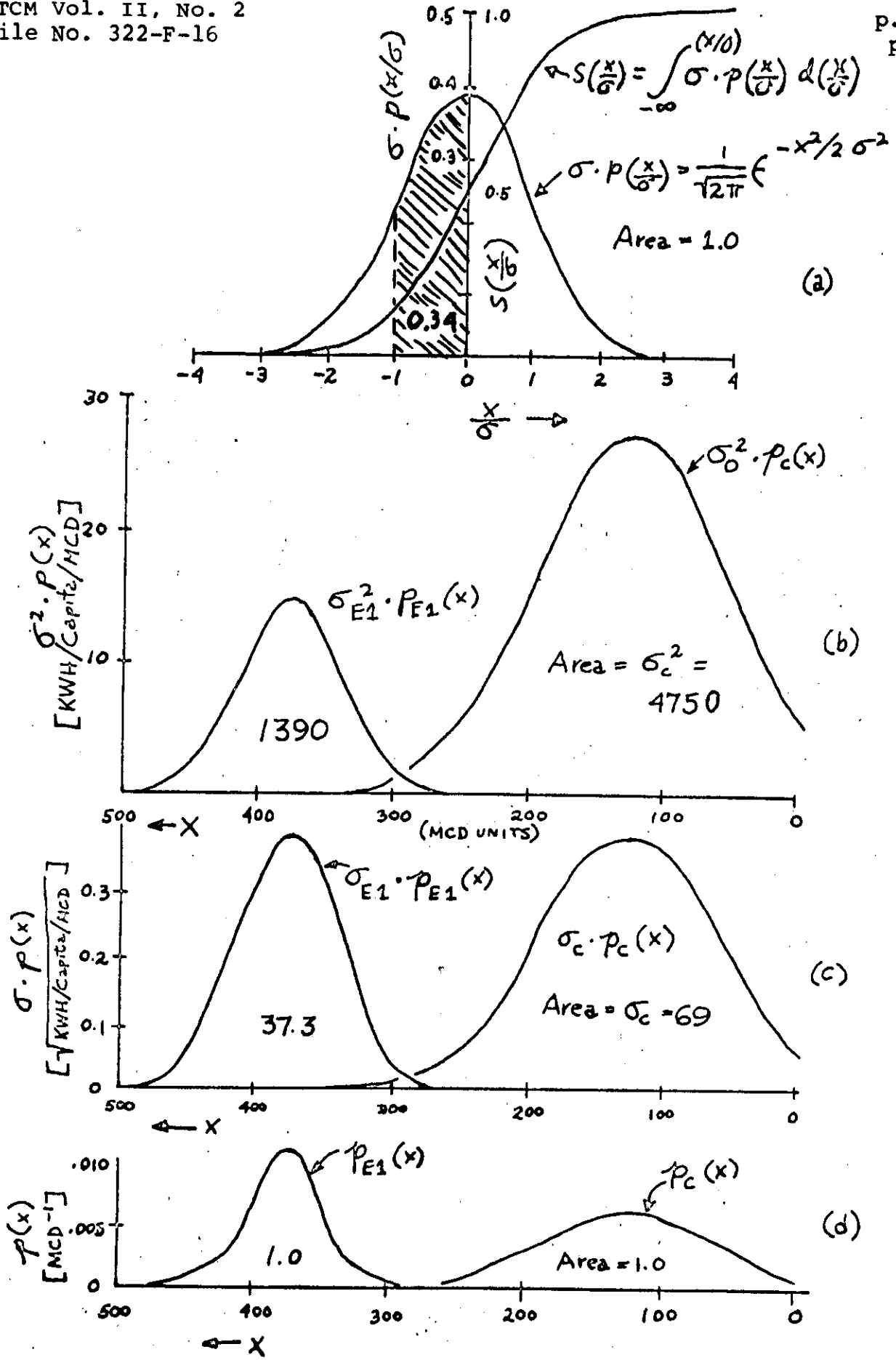Continuous Channel Signal Distributions

$$S\left(\frac{x}{\sigma}\right) = \int_{-\infty}^{(x/\sigma)} \sigma \cdot P\left(\frac{x}{\sigma}\right) d\left(\frac{x}{\sigma}\right)$$

$$\sigma \cdot P\left(\frac{x}{\sigma^2}\right) = \frac{1}{\sqrt{2\pi}} \varepsilon^{-x^2/2\sigma^2}$$

Area = 1.0

(a)

$\sigma_O^2 \cdot P_c(x)$

$\sigma_{E1}^2 \cdot P_{E1}(x)$

(b)

$$\text{Area} = \sigma_c^2 = 4750$$

1390

$\sigma_{E1} \cdot P_{E1}(x)$

$\sigma_c \cdot P_c(x)$

Area = σ_c = 69

(c)

37.3

$P_{E1}(x)$

$P_c(x)$

(d)

1.0

Area = 1.0

Fig. 6 . Different Methods of Plotting Distributions

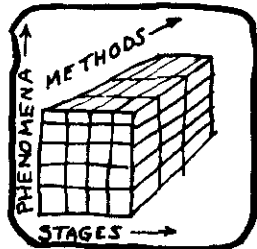To help the reader gain a perspective of where this paper fits into a larger framework, topics and diagrams are shown below:
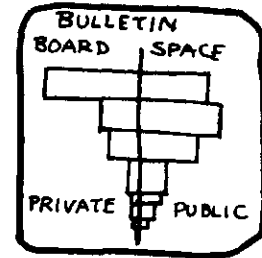

LOG SPIRAL FORM OF PERIODIC TABLE — CHEMICAL ELEMENTS
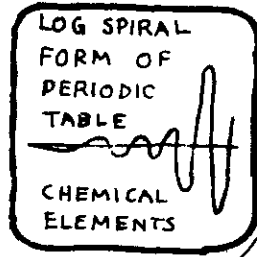
GENERAL SYSTEMS THEORY POINTS TO ISOMORPHIC FEATURES.

BIO-SOCIAL / EVOLUTION
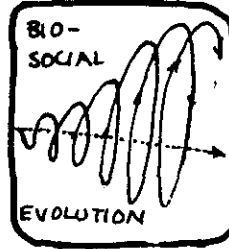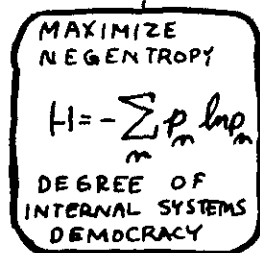
INFORMATION THEORY MEASURES DEGREE OF DEMOCRACY

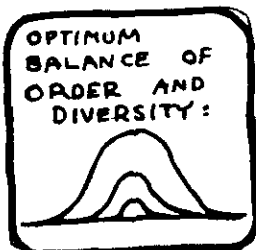CYBERNETICS ANALYSES SIGNIFICANT FEEDBACK LOOPS IN CONTROL SYSTEMS.

PHENOMENA / METHODS / STAGES

DEVELOP AN ETHICS COORDINATING PRINCIPLE.

BULLETIN BOARD | SPACE — PRIVATE | PUBLIC

TECHNOLOGICAL / MEDITATION

MODIFIED THERMODYNAMIC IMPERATIVE

MAXIMIZE NEGENTROPY

$$H = -\sum_m p_m \ln p_m$$

DEGREE OF INTERNAL SYSTEMS DEMOCRACY
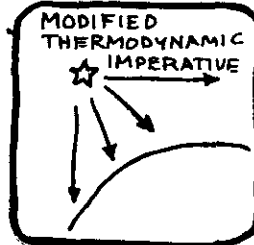
TEST HYPOTHESES IN THE TRADITION OF SCIENCE

OPTIMUM BALANCE OF ORDER AND DIVERSITY:

PHENOMENA LEVELS / SYSTEMS PROPERTIES / ENERGY / ENTROPY / FEEDBACK / ETC.
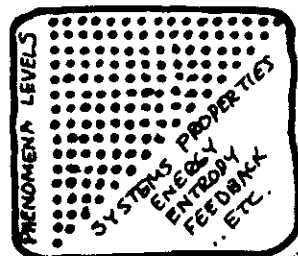
REPRINTS OF SOCIO-ENGINEERING PROBLEMS REPORTS(Available in photocopy
at 7¢ per page postpaid by surface mail):

> Note: I plan to edit the major parts of the
> more significant <u>Socio-Engineering</u>
> <u>Problems</u> <u>Reports</u> into sections of <u>CTCM</u>.
> To avoid ordering SEPR's that have
> already been incorporated into CTCM,
> check the note on extent of overlap
> following the listing.

"The Nature of the Social Responsibility of Engineers," SEPR No. 001-A
April 2, 1971 Reprint of Issue of August 27, 1958, 16pp. (Overlap with
<u>CTCM</u> is 6 out of 16pp.)...............................Price $1.12

SEPR No. 065-D, "Proposed Research Plan on <u>Communication</u> <u>Theory</u>
<u>in the Cause of Man</u>," Selected sections of Research Grant Application
GM-11277-01 of October 29, 1962, 30pp., Reprinted April 25, 1971.
(Overlap with <u>CTCM</u> and other SEPR Reprints is 7 pages out of 30)..
Price for photocopy..... $2.10.

"Biographical Sketch: Frederick Bernard Wood, P.E., Ph.D.," SEPR No.
202-G Updated April 4, 1971, 2pp. ....Price ....Free

"Cybernetic Aspects of Social and Technical Processes that Endanger the
Ecological Balance," <u>SEPR</u> No. 211-B, Oct 9, 1969, 14pp. (Overlap with
<u>CTCM</u> is 5 out of 14 pp.)...............................Price......$0.98

SUBSCRIPTION AND REPRINT ORDER
FORM ON BACKSIDE OF PAGE

BACK ISSUES OF <u>COMMUNICATION</u> <u>THEORY</u> in the <u>CAUSE</u> <u>of</u> <u>MAN</u>:

Vol. I, No. 1-2, June-July 1970(First issued 6/7/70, revised 7/12/70,
revised 8/30/70, Reprinted with minor revisions Nov 1971 and Jan 1972)
Civil rights & evolution; Multidisciplinary concepts; Technological
meditation; The thermodynamic imperative; and Status of entropy and
information. 26pp. Price $1.00.

Vol. I, No. 3-4, Aug-Sept 1970(10/4/70 update) Sociological imagin-
ation, Public bulletin board space, Science and Hypothesis, Modified
thermodynamic Imperative, Letters on thermodynamic imperative, and
Example. 20pp. Price $1.00.

Vol. I, No. 4-X, Oct 1970(10/25/70) Prospectus issue with table of
contents of proposed sections. Graphic abstracts of sections publish-
ed to date. 4pp. Sincle copy free.......additional copies 25¢ each.

Vol. I, No. 5-6, Nov-Dec 1970(3/28/71) Letters; Cybernetics,
Information feedback loops, and Communication Entropy; Perspective.
24pp. $1.00.

Vol. I, No. 7-8, Jan-Feb 1971(7/4/71) Prime Questions and Four
Hypotheses; Rise & Fall of 21 Civilizations; National Priorities;
The COMPUTER and ESALEN; Three Eras of Civilization; List of
Questions; Reviews of Books and Reports. 20pp. $1.00.

Vol. I, No. 9, Mar 1971(8/22/71) Notes, Letters & Questions; Complex
Problems(Sociological Syzygy); Social Responsibility of Engineers
(Historical Development); Reviews of Books, Magazines.. 17pp..50¢

Vol. I, No. 10-11, Apr-May 1971(9/5/71) AN INTEGRATIVE FRAMEWORK
FOR A NEW FRONTIER: Frontier Shock; The Cybernetics Systems
Perspective; Technology in Revolution; Values in Transition;
Putting It All Together/ The Future of Society/; The Future of
Organization; An Integrative Framework For A New Frontier/ A
Tentative Model/; Bibliography; Back Issue List ... 38 pp. $1.00

Vol. I, No. 12, June 1971(3/5/72) Editorial notes; What Has
Cybernetics Got To Do With The Quality and Survival of Human
Civilization; Entropy-Like Properties of Different Levels of
Systems(Abstract); Tables and curves of Uncertainty and Negentropy;
List of questions and Discussion of Hypotheses..18pp. $1.00

Vol. II, No. 1, July-Aug-Sept 1971(6/18/72) Table of Three Eras;
Editorial notes on "thermodynamic imperative"; A Star to Steer
by in a Disconnected Society; Possible Relationship of Political
and Religious Freedom with Maximizing Negentropy(includes discussion
of failure to find completeness theorem); An Application of the
Discrete Channel Model to Political Systems; Sample Calcuations
of Negentropy of a Sociological System; Further Questions. 27pp.
Price $1.00

REPRINTS OF SOCIO-ENGINEERING PROBLEMS REPORTS:

SEPR No. 401, "Entropy and Entropy-Like Properties of Different Levels
of Systems, Their Usefulness and Limitations." July 25, 1971, preprint
for Second Annual Institute of Systems Education of the National Task
Force on Systems Education (Western Division) of the Society for
General Systems Research, San Jose State College, September 9-10, 1971,
21pp. (Overlap with CTCM is 21 out of 21 pages), $1.00 per copy.

Subscription and
Order Form

COMMUNICATION THEORY in the CAUSE of MAN
C/O F. B. Wood, P.O. Box 5095, San Jose,
California 95150

Originally planned as a monthly,
but now issued as a bimonthly magazine. **$1.00 per issue**
    Please enter a subscription at $5.00 for a year or $9.00 for two
years starting with Vol._____No._____. $____.___

Send back issues as follows:
Double size issues:
_____ copies of CTCM Vol.___No.____@ $1   Name _____

Single size issues:
_____ copies of CTCM Vol.___No.____@ 50¢ Street _____

Reprints or photocopies of SEPR's: City _____
Nos:_____Price_____
(Photocopies at 7¢ per page)   State _____Zip _____
            Total order $____.___
For foreign airmail, add $3.00 extra per year.