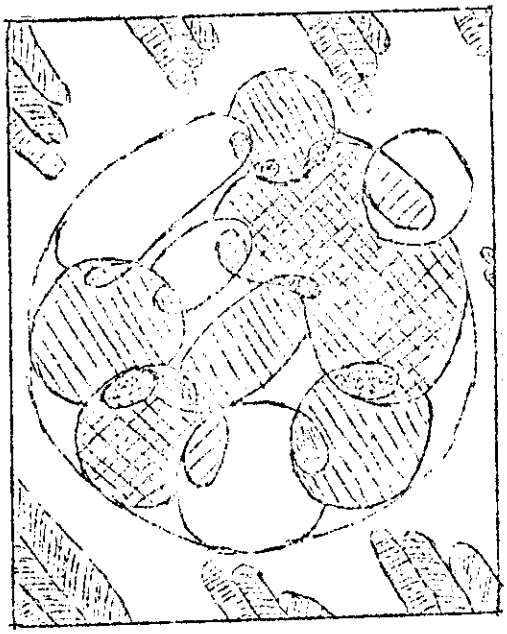
October 10, 1962

Proposed Research Plan

on

"Communication Theory in the Cause of Man."

A Study in the Philosophy of Science from an "Engineering" Viewpoint with Emphasis on Communication Theory including Information Theory and Cybernetics plus Necessary Fundamentals from Mathematics and the Scientific Method in a Way Which May Bridge the Gap between "The Two Cultures" of the Humanities and the Sciences.



A Man and Computer Struggling to Cope with the Problems of an Increasingly Complex Society

Frederick B. Wood, Ph.D.
P.O. Box 85
Campbell, California

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Proposed Research Plan

on

"Communication Theory in the Cause of Man"

by

Frederick B. Wood, Ph.D.

Abstract

An inquiry into the feasibility of using certain analogies from mathematics and the physical sciences and in particular from cybernetics and information theory to bridge the gaps between the different fields of specialization in science. Although this process is proceding step by step in the growth of science, a fresh organization of the material is proposed which has potential for both speeding up the application of these concepts and providing awareness of the potential misapplication of such concepts. This study is oriented toward the "engineering viewpoint" based on the Engineers' Council for Professional Development definition: "The engineer may be regarded, therefore, as an interpreter of science in terms of human needs and a manager of men, money, and materials in satisfying these needs."

The specific objectives of this project are:
(1) To determine if analogies from the physical sciences can accelerate applied research in the social sciences;
(2) To improve the communication between different cultural groups in the world so that it will be easier to develop non-violent ways of solving national and international problems;
(3) To explore how the conceptual tools already available might be used more effectively by groups devoted to peace and freedom.

This specific proposal is estimated to take less than one man-year starting from the manuscripts and experience already accumulated. An outline of an extension of this project which would take several years is outlined in the appendix. The work proposed for this year is:
(1) Explain and define concepts of communication theory for the layman and scientists in other fields;
(2) Develop and test a series of simple examples; and
(3) Write the results in the form of a large pamphlet or small book under the title "Communication Theory in the Cause of Man."

Proposed Research Plan on "Communication Theory in the Cause of Man."

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Frederick C. Rose
October 17, 1967

[illegible] draft

for

Processed Research Plan on "Communication Theory in the Cause of Man."
(October 16, 1967)

p. 1, 1st par., 1st line, last word: different

p. 16/17, 1st par., 2nd line, last word: or

2th line, 4th from last word: until

p. 15, introd. note, last line, next to last word: trans-national

par., 1st line, 2nd word: different

p. 3, 2nd line, 4th word: route;

3rd par.,4th line should end:

.....to be list of rifters to be

p. 7, 1st par., 2nd line, 3rd word: nature

3rd par., 1st line, 2nd word: pause

p. 4, 2nd par., 8th line, last word: difference

p. 5, 5th line, 4th word: choosing

7th line, 4th word: appropriate

p. 11, 1st par., 2nd line 2nd word: or

4th line, last word: conclusions

p. 12, 2nd par., 1st line should end:

.....to be difficult, however

p. 15, 2nd par., 3rd line should end:

.....higher than average, due to

I. INTRODUCTION TO THE PROBLEMS.

A. URGENT NATIONAL AND INTERNATIONAL PROBLEMS.

Western European Civilization including the United States of America has been going through periods of crisis which have gone into intense phases in World War I and World War II followed by a fluctuating Cold War phase. Sensitive people have perceived the impending peak phases well in advance. For example the writer, Jack London, foresaw the possibility that both business and labor leaders who started out with high ideals could drift into supporting a dictatorial oligarchy as outlined in his novel, The Iron Heel (1907). (1) Eugen Rosenstock-Huessy, a philosopher professor at Leipsig, in 1938 published an important book outlining the development of human liberty with due attention to the process by which each step forward of civilization required some protecting principle and a corresponding institution to prevent a relapse from the stage already reached. (2) His analysis was developed too late to prevent fascism and World War II.

In 1940 Dr. Frank B. Jewett, Chairman of the Board of Directors of the Bell Telephone Laboratories, and Dr. Robert W. King, Assistant Vice-President of American Telephone and Telegraph Co. asked is it not possible after this conflict is settled, to put as much thought and physical effort into a "way of total peace" as has gone into this preparation for a total war? (3)

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(1) Jack London, The Iron Heel N.Y.: Macmillan (1908)

(2) Eugen Rosenstock-Huessy, Out of Revolution: An Autobiography of Western Man. Trans. from German, N.Y.: Morrow (1938)

(3) "A Way of Total Peace," (editorial) Journ. Applied Physics, vol. 11, No. 12, Dec. 1940, p. 749 and "Engineering Progress and the Social Order," Science, vol. 92, 365- , 1940.

Archibald MacLeish pointed out the lack of communication between specialists and lack of real contact of the specialists with the crucial problems of our civilization back in 1940.(4) The October 1940 issue of Journal of Applied Physics reviewed MacLeish's book:

> "Archibald MacLeish has made a declaration and a challenge. He accuses physicists and scholars in all fields of having divided learning into narrow cucibles; each particular scholar being conscientious, laborious, competent and supreme in his own little section but absolutely disinterested in the society or the culture that has made his bit of freedom possible or in his responsibility for its continuation....."

When under attack in World War II, the American people responded to the challenge of the Nazis, Fascists, and the Japanese Militarists who were attacking the common elements of Western culture upon which our tradition of freedom and goals of deomcracy are based. After World War II was over, people relaxed and failed to pursue vigoriously the all-out attack needed on the social problems of the world. Enough people saw potential military dangers to pursue new weapons systems to have the military force to protect democratic institutions. However the development of the Hydrogen bomb and advanced delivery systems has brought us to a new crisis.

If another war should start, it could mean the end of the human race on our planet due to radioactivity, chemicals, or germs. This means that we have to find new methods of defense, preferably techniques which will permit us to find non-violent methods of resolving international conflicts.

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4. Archibald MacLeish, The Irresponsibles. N.Y.: Duell, Sloan and Pearce (1940)

Famous writers and editors such as Norman Cousins (5) and a host of religious leaders have warned of the dangers to civilization.(6)

So far the exhortations of famous writers and great religious leaders have not produced any spectacular change in the trend of international affairs. Good intentions must be supported with better insights as to the nature of the social processes going on in the world. Significant strides have been made in the behavioral sciences in the last decade, but if one looks at the list of problems to be solved, the list of problems untouched is staggering compared to the small amount of funds allocated for such social science research of significance to the problems of world peace and freedom. For example, the Institute of International Order has issued a series of reports called "programs of research" which list the problems in given areas of international relations. Their Program No. 4: National and International Decision Makers contains the definitions of 56 possible reaerch projects, and Program No. 5: Communication and Values in Relation to War and Peace, lists 44 possible projects. If all the above projects were financed, I probably wouldn't bother to write this research proposal.

My object is to see if there are ways to approach these problems with a basic philosophy which has power of overlapping sets of problems or of finding a way of looking at the problems so that they can be related to problems which are already solved in other

5. Norman Cousins In Place of Folly N.Y.: Harper & Bros.(1961) and Paperback Edition, N.Y.:Washington Square Press (1962)

6. God and the H-Bomb, Donald Key,editor; Foreword by Steve Allen. N.Y.: Bernard Geis Associates (1961); Paperback edition:N.Y.: Macfadden Books(1962)

fields of art and science. Margaret Mead has proposed that "a restatement of the Soviet and the American socio-economic-political system in cybernetic terms" in order to enhance the possibilities of fruitful communication between the U.S.S.R. and the U.S.A.(7)

The above proposal may be very promising, but it should be examined carefully. There have been cases where the fast communication of information has amplified insigificant events into castastrophic events such as a rumor hitting the stock market at a strategic time. It might be that some of the things that occur in one country that would irritate another country are less likely to cause violent crises if the communication is slow.

It is instructive to examine typical analyses of the social effects of cybernetics and automation, called "cybernation" by some, to see what national problems are anticipated. A recent report by Donald N. Michael (8) contains some conclusions which indicate a serious possibility of the failure of our country to succeed in achieving the democratic goals stated in a report on Technological Change in Goals for Americans.(9) If our society twenty years from now does reach the state predicted by Dr. Michael in which:

> ".....the research realm of scientists, the problems of government, and the interplay between them will be beyond the ken even of our college graduates,"

the responsibility for achieving the goal of;

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7. Note in ITEMS (newsletter of the Society for General Systems Research, 787 United Nations Plaza, New York 17, N.Y.) Nov. 1961.
8. Donald N. Michael, "Cybernation: The Silent Conquest" A Report to the Center for the Study of Democratic Institutions, January 1962, Box 4068, Santa Barbara, California
9. Thomas J. Watson, Jr., "Technological Change," Chapter 8 in Goals for Americans, The Report of the President's Commission on National Goals, The American Assembly, Columbia University, N.Y.: Prentice-Hall(1960).

"Technological change should be used to improve men's lives,"

would rest upon the shoulders of a small elite, o might be corrupted by power to follow the path of Mussolini or Stalin.

It is valuable to see what Soviet thinkers have to say on the social consequences of cybernetics. E. Kol'man has written:

(Abstract)"The real dangers differ in social and capitalist countries. In capitalist nations the greatest danger is that cybernetic technology will result in mass unemployment or economic crises which may lead to war. In socialist countries the real danger is that cybernetic technology will bring such a reduction in physical and mental labor that physical and moral degeneration may result."(10)

To evaluate the validity of the predictions of Dr. Michael or of Mr. Kol'man it is desirable to establish the most basic and fundamental basis of analysis.

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10. E. Kol'man, "Cybernetics Raises Questions,".7 Feb 62, 6pp. JPRS; 12288 (OTS 62-15771); Trans. of Nauka i Zhizn'(USSR) 1961, v. 28, no. 5, pp. 43-45. (Abstract in TECHNICAL TRANS. v. 7, no. 10, May 30, 1962)

B. STEPS TAKEN BY THE AUTHOR TO APPROACH THESE PROBLEMS.

Back in 1958 the author happened to be working with a few engineers who were interested in the important problems of our civilization. After some informal discussions a public panel discussion on "The Social Responsibility of Engineers" was sponsored by the Santa Clara Valley Chapter of the California Society of Professional Engineers in which a philosophy professor and two engineers discussed the question. Some of the material was written up for the Western Joint Computer Conference[11]

The philosophical concepts discussed in the August 1958 panel discussion and the specific example used in the 1959 WJCC paper are illustrated by Fig. 1. First the vertical coordinate is based upon levels of phenomena like the founders of Sociology: Auguste Comte, Herbert Spencer, and Lester Ward[12] used in classifying the sciences. The most fundamental phenomenon - physical - is placed at the base, with the others on top in order of complexity. The horizontal scale is divided into sections by class of activity: starting from basic science on the left and moving through applied science or engineering to education to decision and action. The resultant rectangular block is shown with a break, roughly corresponding to the gap between the "Two Cultures" of C. P. Snow.[13] The front section is the domain of the physical and mathematical sciences. The back section represents the domain of the humanities.

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11. F. B. Wood, "The Social Responsibility of Engineers and Scientists," 1959 Proc. Western Joint Computer Conference, pp. 310-313; March, 1959.

12. Samuel Chugerman, "Lester F. Ward, The American Aristotle," Duke University Press, Durham, North Carolina; 1939, pp. 88-91.

13. C. P. Snow, "The Two Cultures and The Scientific Revolution," Cambridge University Press, New York; 1961.

(1) His special work: computer-data communication,

(2) The potential new system resulting, such as a universal credit system replacing money,

(3) The possible social consequences,

(4) What are the real problems remaining after seeking expert advice, and

(5) What level of action is required?

The wavy-line arrows from the social phenomenon level of the humanities section to the checking chart symbolize how the engineer in the process of this analysis has woven two threads across the gap through his consulting with a philosopher and a lawyer. There are two ways known by which this process can be extended: one by many engineers making small threads across the gap by reviewing their own work in this manner, and second a more powerful approach lies on the horizon, namely the extended use of analogies from cybernetics and information theory to bridge the gap between the humanities and the sciences and to bridge the gaps between the special fields within science.

Since the presentation of the social responsibility paper, the author has given considerable thought to the second or more powerful approach of extending the common forms of negative feedback loops of cybernetics, the form of channel capacity curves from information theory, and the coding processes of information theory across the boundaries of the different fields of specialization. An outline of a proposed book has been prepared. Since the first outline represents a project that would take many years to complete, it is given briefly in the appendix. The most basic elements of the proposed book have been distilled out and used for the description of this particular proposal in sections II and III as a project within the range of a one man-year effort.

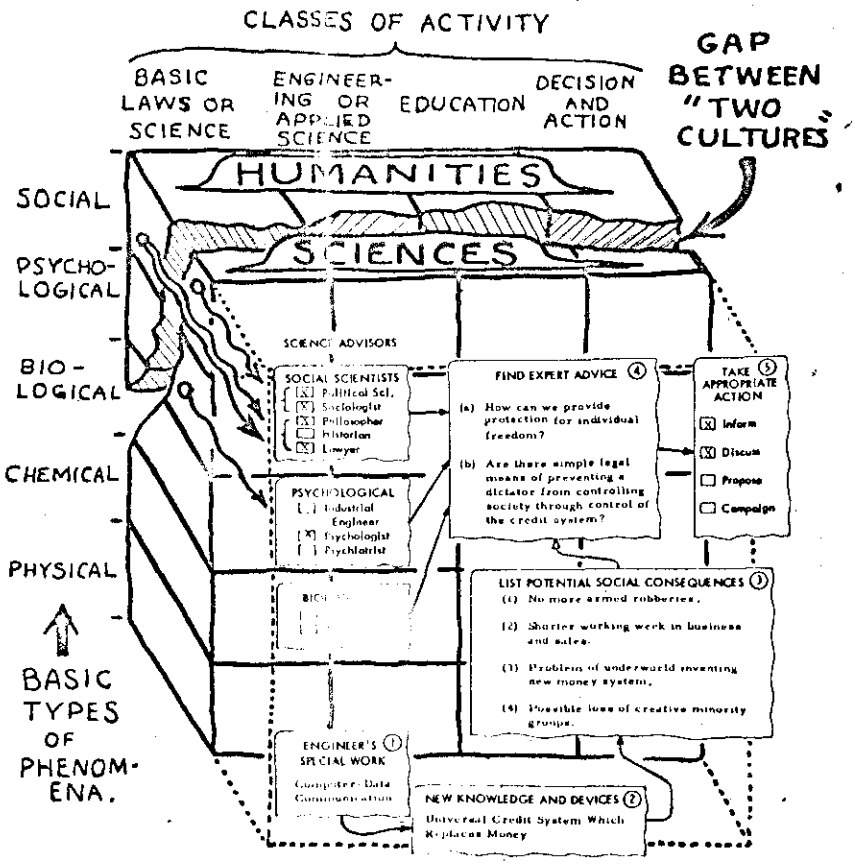

Fig. 1. A Checking Chart Superimposed Upon A Classification System For The Sciences and The Humanities.

Now the consideration of the social responsibility of an engineer for his own work can lead to a small thread across the gap. To illustrate this the "checking chart" from the 1959 WJCC paper has been superimposed upon the face of the science classification block. Information for one special case has been filled in on the chart as an example. For more details on the following five steps one can refer to the original paper[11] or to the review and extension issued by Canning and Sisson[14]. The engineer considers:

14. "Direction and Control of Technological Change," Data Processing Digest, Canning, Sisson and Associates, Inc., Los Angeles 35, California, vol. 7, no. 2, pp. 18-22; February, 1961.

C. NEW CHALLENGES REGARDING THE USE OF CYBERNETICS.

It is becoming more important for the scientists, engineers, and philosophers of the United States to explore new approaches to the application of cybernetics to social phenomena, because philosophers and scientists in Europe and the Soviet Union are developing reports and books claiming to be using cybernetics to attack religion[15], claiming that cybernetics is an example of dialectical materialism[16], and announcing a program to produce a three volume works on "Cybernetics At The Service of Communism" [17]. It is very important that the United States develop the capability of evaluating these claims, so that false claims can be refuted, and valid claims can be assimilated in a way to protect individual freedom. Soviet propaganda could omit analogies from information theory which conflict with concepts like "the dictatorship of the proletariat," while using other analogies to influence world opinion by distorted applications of cybernetics.

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15. I. P. Gutkin and K. E. Morozov, "Cybernetics Attacks Religion," Report JPRS-6655, Selected Translations from Nauka i Religiya (Science and Religion)- USSR, 30 Jan 1961, U.S. Joint Publication Research Service, Washington 25, D. C. , pp. 1-5.

16. Georg Klaus, "Relationship of Causality and Teleology from the Cybernetic Viewpoint," trans. from Deutsche Zeitschrift fur Philosophie, West Germany, vol. 8, pp. 1266-1277, 1960; Report JPRS-8374, June 1961(Abstract in Technical Translations, Washington 25, D.C., vol. 8, p. 306, Aug. 15, 1962)

17. A. I. Berg, editor, "Cybernetics At The Service of Communism- USSR," trans. of Vol. I of book; Report JPRS: 14593, 25 July 1962, 435pp., Joint Publication Research Service, Washington 25, D.C.

II. EXPLANATION AND DEFINITION OF CONCEPTS OF COMMUNICATION THEORY AND NECESSARY PARTS OF BASIC MATHEMATICS AND THE SCIENTIFIC METHOD FOR THE LAYMAN AND SCIENTISTS IN OTHER FIELDS.

Introductory Note

When one reviews the pioneer work of Norbert Wiener and Claude Shannon; the series of Macy Conferences; the four London Symposia; and more popular descriptions by Colin Cherry, G. T. Guilbaud, W. Ross Ashby, D. A. Bell, and J. R. Pierce; plus the works on mathematics and science edited by James R. Newman one could easily ask: "Why is there another study proposed covering the same material?" It is true that there will be some overlap of existing material, Where this occurs it will be for an important purpose: namely to point the way to a new synthesis of the known concepts which can develop a philosophy more suitable for establishing communication across special fields and with the educated layman, so that the dangers predicted by Michael and Kol'man can be prevented.

A. COVERING THEOREMS(Mathematics)

The mathematician is very careful and precise in defining the space in which he is working. When the mathematician wants to integrate functions over a particular space, he examines the space very carefully. He develops "covering theorems" which define the properties of the space, how he can subdivide the space, and how he can count the points in the space. This careful preparation permits him to go on to establish theorems on how to

integrate functions in the space. It is proposed that an interpretation of this cautious procedure of the mathematician be developed based upon the formal developments given by Titchmarsh(*), Graves(♪), and McShane(#).

It is important to be aware of invalid, premature, and bona-fide applications of mathematics to social phenomena. Abraham Kaplan ($) has described S. C. Dodd's 1942 attempt to apply mathematics to the social sciences as a misguided attempt. Kaplan also points out how Rashevsky's books are valuable in that they actually use mathematics, but some of his examples are too naive.

To get back to mathematics and the careful development of theories of integration, some examples of the difficulties with particular spaces and functions are described by Hans Hahn.(¢) He gives some examples of mathematical curves where precise logic shows that our intuitive thoughts regarding these curves would give incorrect results.

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* E..C. Titchmarsh, The Theory of Functions, London: Oxford Univ. Press, Second Edition(1939)

♪ Lawrence M. Graves, The Theory of Functions of Real Variables, N.Y.: McGraw-Hill(1946)

\# Edward James McShane, Integration, Princeton Univ. Press(1947)

$ Abraham Kaplan, "Sociology Learns the Language of Mathematics," in The World of Mathematics, vol. 2, pp. 1294-1313.

¢ Hans Hahn, "The Crisis in Intuition," in The World of Mathematics, vol. 3, pp. 1956-1976.

B. PARTIAL DERIVATIVES AND SERIES EXPANSIONS (Mathematics and Mathematical Biophysics).

When a mathematician has a problem properly defined on a space, i.e., he has the space defined, the boundary conditions are known, and the basic differential equations governing the phenomena are known, it still may be difficult to find an exact solution. When he cannot find an exact solution in closed form, he must choose as to what incomplete answer would be of value.

(1) He may decide it is important to find a complete solution for a region lying within a certain radius of a particular point in the space, or

(2) He may decide that solving for one particular partial derivative may give him the needed information on how the system changes with changes in one particular parameter.

To use the first approach the mathematician must develop a series expansion in terms of functions which satisfy the differential equation and must verify that the whole series is capable of providing a complete solution in the region of interest. For the second part he must take a partial derivative of the exact solution or of the series expansion.

For this section I plan to develop a semi-popular account based on the standard treatment from a textbook like Woods & Bailey(*). It would be aimed at helping the layman be able to better perceive the significance of articles in Bulletin of Mathematical Biophysics and books like Mathematical Biology of Social Behavior(ŷ).

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* Frederick S. Woods and Frederick H. Bailey, Analytic Geometry and Calculus. Boston: Ginn & Co.(1917), pp. 136, 335, 410-412.

ŷ Nicolas Rashevsky, Mathematical Biology of Social Behavior(1951)

C. QUANTIZATION OF TRUTH AND CHANNEL CAPACITY (Information theory)

Since philosophers, lawyers, and theologians have differnet definitions of "truth", perhaps a better phrase to start out with would be "quantization of information" instead of "quantization of truth." The example used by MacLachlan in his article in Information and Control on "Description Mechanics" provides an example of a picture of a leopard in a tree. If the resolution of a reproduction of the drawing is very coarse, it is hard to make anything out of it. If the resolution is medium the leopard can be recognized easily. If very fine resolution is used the leopard may be camouflaged by the detail of the leaves. The first part of this section would be limited to explaining the range of information content for different types of physical images.

The second part of this section would define a communication channel and review Shanon's(*) basic theorems on channel capacity of the following cases:

Noiseless discrete channel,

Discrete channel with noise, and

Continuous channel with gaussian noise.

If it turns out that these basic concepts are already explained on the appropriate level for this project by writings of J. R. Pierce (#), Jacob Bronowski ($), or D. A. Bell ($), I would consider asking the appropriate author to consider arranging permission to copy the suitable material.

* Claude E. Shannon and Warren Weaver, The Mathematical Theory of Communication. Urbana: Univ. of Illinois Press(1949)

\# J. R. Pierce, Symbols, Signals and Noise: The Nature and Process of Communication. N.Y.: Harper & Bros.(1961)

$ Jacob Bronowski, "Science as Foresight," in What Is Science?(1961)

$ D. A. Bell. Intelligent Machines. N.Y.: Blaisdell Pub. Co.(1962)

D. CODING THEORY (Information Theory)

This material would be an elementary discussion of binary coding of messages in English, particularly illustrating the redundancy involved. Then it would be shown how the redundancy can be removed, and new redundancy added in the form of error-detection or error-correction coding which is more efficient for machine coding and decoding. The source materials would be primarily the same references as in Section C plus material by Colin Cherry(*).

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* Colin Cherry, On Human Communication. N.Y.: Wiley(1957)

E. ENTROPY (Information Theory)

This would be an elementary description and definition of entropy as used in thermodynamics, statistics, and information theory. This also would be based on the basic references of the previous two sections, plus possibly some material by Brillouin(♪) and By Tribus(#).

♪ Leon Brilloin, Science and Information Theory. N.Y.: Academic Press(1956)

\# Myron Tribus, "Information Theory as the Basis for Thermostatics and Thermodynamics," Yearbook of the Society for General Systems Research, vol. VI(1961), pp. 127-138.

F. NEGATIVE FEEDBACK AND POSITIVE FEEDBACK CIRCUITS (Cybernetics)

This section would be an elementary description of negative feedback circuits of cybernetics similar to parts of Guilbaud's (*) little book. To be of deeper value to the layman, particularly for extension to different types of phenomena, some graphical illustration of positive feedback is needed. The discussion of D. Stanley-Jones (#) are important, but fail to make real contact with the mathematical formulations of cybernetics. An important part of this section will be to interpret recent work such as that of Magoroh Maruyama on positive-feedback processes.(§)

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* G. T. Guilbaud, What Is Cybernetics? N.Y.: Grove Press(1960)

D. and K. Stanley-Jones, The Kybernetics of Natural Systems, A Study In Patterns Of Control. London:Pergamon Press(1960)

§ Magoroh Maruyama, "Morphogenesis and Morphostasis," METHODOS, vol. 12, No. 48, 46pp.

Magoroh Maruyama, "The Second Cybernetics: Deviation-Amplifying Mutual Causal Processes." Preprint, Sept. 1962.

G. TESTING OF HYPOTHESES (Scientific Method).

First we must inquire how the scientist decides to accept a particular hypothesis like the Einstein Special Theory of Relativity.

In many fields of science we never have absolute proof of a law, but have to be satisfied with testing hypotheses and using the hypothesis which is most consistent with the known facts. Maxwell's equations have not been derived from more

fundamental laws. The Special Theory of Relativity is an interesting example. It is one of seven competing theories listed in Fig. 2.(*) Examining the status of agreement of disagreement of each theory with the thirteen experiments, we see that Einstein's Special Theory of Relativity is the only one of the theories that has no contradictions. Therefore we accept the Special Theory of Relativity ultil we find some experiment which results in a contradiction.

This outline of the experimental basis shows that experiment contradicts any reasonable alternative to the theory of Relativity, rather than any single experiment proving the theory. The experiments outlined above presen evidence that:

(1) The presence of an ether, either stationary or convectively carried, cannot be established.

(2) Modification of electrodynamics of the emission theory type is untenable. The conclusions then make it plausable to look upon the basic laws of mechanics as in need of modification.

In 1905 Einstein proposed as a solution, compatible with the experimental facts known at that, the following postulates:

(1) All laws of electrodynamics (including, of course propagation of light with the velocity c in free space) shall be same in all inertial frames, as are the laws of mechanics.

(2) It shall be impossible to devise any experiment defining a state of absolute motion or to determine a preferred inertial frame having special properties for any physical phenomena.

It is clear that if the laws of physics obeyed these postulates, all the experimental facts outlined above would be in agreement with these postulates.

*. Wolfgang K. H. Panofsky, Classical Electricity and Magnetism, Physics 210B, University of California Syllabus UC, March 1949, pp. 249-251.