"Cybernetics and the Next Step in Civilization"

by

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A discussion of the role of Cybernetics in simplifying the solution of the transitional problems of human civilization in moving from the power era to the information era. A hypothetical university of the future is used to illustrate the relationship of the different fields of science, engineering, education and management. In the example the physical structure of the buildings fits the logical relationships between the sciences.

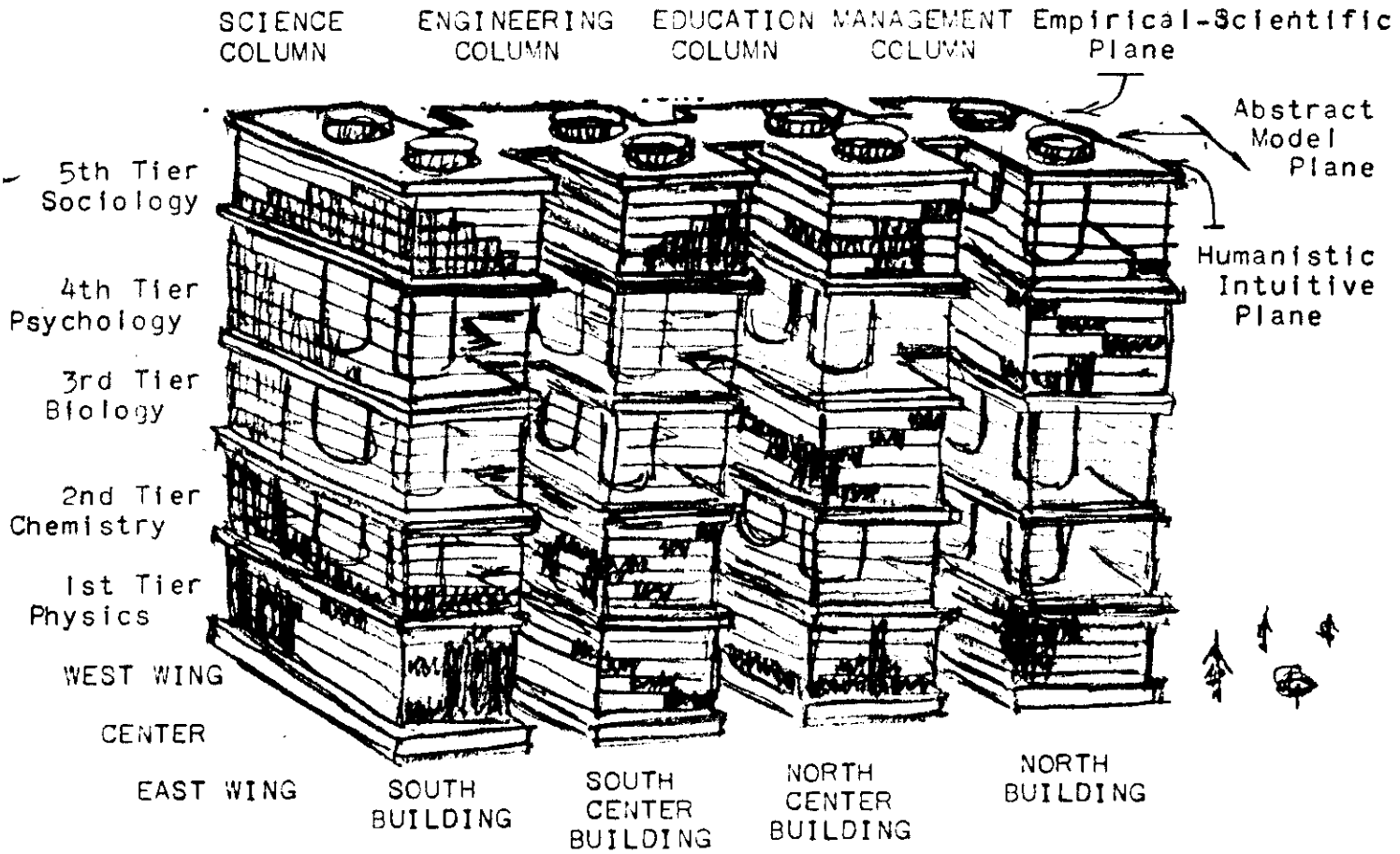

Fig. 1. An Inter-Disciplinary Structured University of the Future

CYBERNETICS(1) AND THE NEXT STEP IN CIVILIZATION.

As human civilization moves into each more complex stage of development, a central theme or organizing principle emerges. As human society evolves towards a further stage, the present theme can degenerate into an instrument for the destruction of human values. For example St. Anselm's motto (1033-1109) "credo ut intelligam" translated as "to believe is to understand," or more poetically "truth is divine and has been divinely revealed" helped organize the renaissance of arts, crafts, architecture, city planning, development of universities, etc., under the leadership of the Church. But the same principles led to the Inquisition in the 14th to the 16th centuries.(2)

Descartes' motto (1596-1650) "cogito ergo sum" translated "I think therefore I am" or more abstractly "truth is pure and can be scientifically represented" signalled a great upsurge of development of science. However this scientific engineering economic activity led to the ammunition factory, two World Wars, and the weapons revolution including atomic and hydrogen bombs, and guided missiles.

As far back as a hundred years ago, and more actively in the last twenty years, philosophers have been trying to launch the theme of the next step in civilization. One philosopher, Rosenstock-Huessy, has tried to state the need of this stage of development in the form of a motto "respondo etsi mutabor" translated directly "yet an exchange must be promised in return" or more symbolically as "truth is vital and must be socially represented." These attempts based upon religious ethics and political philosophy

have not yet succeeded, because they lacked a structural interaction between the content of the humanistic studies from which derive the religious and political concepts and the concdpts of physical science. C. P. Snow's gap between the two cutlrues cannot be bridged by order or wishful thinking.(3) Only by concrete advances in science, technology, and the humanities can a bridge be constructed.

For a vialbe relationship between physical science and the humanities to develop, there must be some relationship between the form of the physical and sociological phenomena plus some coupling between significant quantities and qualities in botn the humanities and the physical sciences. Hegel perceived a fragment of this problem, but his laws of quantity into quality, and vice versa, led to the dictatorsnip of the state. Despite Marx' and Engels' humanitarian attempt to turn around Hegel's concepts, their philosophical system was still coupled to thermodynamic processes which increased entropy, staying in the "power era." (4) In 1835 the celebrated physicist and mathematician A. M. Ampere coined the word "cybernetique" from the Greek kybernētikē to describe the study of the means of government, but his work was not accepted. (5)

In 1928 the famous astronomer, Sir A. S. Eddington grouped categories of scientifically measurable and non-measurable values.(6) Examples of the first class are distance, mass, and electric force; of the second class are beauty and melody. He then found that entropy the physicists' measure of the amount of non-useable energy, seemed to fit partly in both classes, making "entropy" a potential link between humanistic values and empirical science measurable

quantities. In 1929 the Hungarian physicist Leo Szilard pointed out more clearly the relationship between entropy and information. (7)

During World War II the role of the helmsman (kybernētēs) became more significant through the development of servomechanisms in the U.S. Navy (8) and through the development of fire control feedback systems conceived by Norbert Wiener. (9) The technology of electrical processing of information was greatly advanced by the refinement of radar by the M.I.T. Radiation Laboratory. (10) These and other developments led to N. Wiener's formulation of Cybernetics and Claude Shannon's Mathematical Theory of Communication (Information Theory) in 1948. (11) These developments plus the development of high speed electronic computers and the weapons revolution have put mankind at the threshhold of a new era--the "Information Era." (12) *

For this analysis I shall include Information Theory as a part of Cybernetics following the European practice. To visualize the role of Cybernetics in constructing the bridge across the gap between the sciences and the humanities, let us imagine a new university housed completely in one specially designed skyscraper, (13 as is illustrated by Figure 1. This building is of unusual construction, in that there are no load bearing walls. The building is a set of four buildings, each of which is a set of twenty-five floors supported by massive cylinorical hollow columns which contain stairways, elevators, and utilities. Before occupancy the

*Since preparing this manuscript, two books have come to my attention which deal with an important concept for basing a system of ethics in the "Information Era"---namely the "Thermodynamic Imperative" which is developed by R. B. Lindsay in The Role of Science In Civilization, N.Y.: Harper & Row (1963) and is discussed by Henry Margenau in Ethics and Science, Princeton: Van Nostrand (1964).

building looked like an open-walled parking garage. There are four buildings connected by two passageway sections between each adjacent building. The four buildings, one for each class of activity: south bldg/SCIENCE; south-center bldg/ENGINEERING; north-center bldg/EDUCATION; and north bldg/MANAGEMENT. Each building is divided into three columns of planes by method: East Column/HUMANISTIC-INTUITIVE; Middle Column/ABSTRACT MODELLING; and West Column/EMPIRICAL-SCIENTIFIC.

The floors are grouped into tiers of five floors each assigned to different phenomena such that the first or bottom tier is PHYSICAL; second is CHEMICAL; third is BIOLOGICAL; fourth is PSYCHOLOGICAL; and the fifth or top tier is SOCIOLOGICAL PHENOMENA. Within each tier the floors would be divided by size of the phenomena, i.e., in physics, the bottom floor would be elementary particles, the second atomic physics, the third molecular, the fourth human size, and the fifth astronomical. In the psychological and sociological tiers the size ranges, for two floors each, from individual, small groups, big permanent organizations, national cultures, to relationships between national cultures.

Only the sections of floors that are occupied by current teaching or research activities have windows (glass walls) installed and are furnished. Thus sections of the buildings which are unoccupied due to knowledge not having advanced to that area yet, or that area, for example astrology, that has ceased to be considered of significance, would be left unfinished and open to the breezes.

In each of the four buildings, there is a branch of CYBERNETICS in the Middle Column which can provide a link between the East and

West Columns. By East and West we mean both the opposing methods of the humanistic-intuitive approach and the empirical-scientific approach: and the different cultures of the East(China, India) and the West(Europe and U.S.A.).

To start with the applied science of engineering columns, on the center column, bottom floor we have the Computing Center. On the middle floor we have an applied information theory center devoted to "maximizing negative entropy." This applied concept forms the basis of a powerful analogy for linking the telegraph and computer-communication systems of the bottom floor of the empirical science column with the top floors (psychology and sociology) of the humanistic/intuitive column. In the lower floors of the empirical science area the concept "maximizing negative entropy" corresponds to improving the efficiency of the computer-communication system based on a discrete noiseless channel. In the upper floors of the humanistic/intuitive area the same concept comes close to mathematically representing Albert Schweitzer's principle of "Reverence for Life."

The analogy leading to "reverence for life" only includes a static measure. To find a measure that is dynamic, i.e., containing a measure of the stability of social system that has made some progress toward its goal of "Reverence for Life," we must return to the bottom floor of the empirical science or abstract model section and borrow a more complicated model from Information Theory to determine the optimum message distrubution for a continuous channel. Using this more sophisticated model, one can determine an idealized distribution (or variance) of political ideas needed at a given stage of development of a country to

maximize negative entropy. This would set a connection between physical properties such as per capita power production and the variance in a political idea distribution treated as a social system.

Next for a longer more detailed study, we go to the BASIC SCIENCE columns. In the center an abstract model consisting of a negative feedback loop and amplifier represents electrical and mechanical control circuits on the lower floor of empirical science, and forms a start to the visualization of the psychology of a deveroping child. On the sociological level a more complicated matrix representation is needed, but the basic negative feedback loop provides a starting analogy and symbol.

On the Education section anotner part of Cybernetics and Information Theory comes into play, namely the concept of 'channel capacity'. (14) A telegraph line may be able to handle 3000 bits per second. Likewise on the biological level the optic nerve can process about 3000 bits per second. On the psychological levels a human monitor of radar oscilloscope patterns can process about 300 bits per second. On the sociological level, the individual operator can send information on at the rate of 12bits per second. The next larger size of organization can only transmit about 2 bits per second. The lesson for the humanistic/intuitive column to the East is that education projects must be broken into units that people can understand.

CODINGon the physical plane is the translation of letters of the alphabet, computer instructions, pictures, and other patterns into machine readable electronic signals. The concept of coding can be expanded into three aspects, namely transmission of

meaning, control of errors, and reduction of transmission time. On the chemical and biological levels we have the genetic coding through the DNA molecules in the genes which carry the code for reproduction of living cells. (15) As we switch over to the humanistic/intuitive side we find that there is the possibility of semantic coding. On the intersection of the humanistic column with the sociology level we perceive the potentiality that political ideology may perform a role similar to facsimile compression coding on the physical/empirical science intersection.

June 14, 1964

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Addendum

The above note indicates the potential integrating philosophical use that Western Civilization could make of the concepts of Cybernetics. While we are debating the merits of such an application of the concepts of Cybernetics, the Soviet Union has been rushing ahead in the application of Cybernetics through conferences, setting up new scientific institutes, and planning a vast computer-communication network to simulate and control their economic system.(*) The United States scientific, industrial, and political circles have been slow to respond to this challenge. The organization of the American Society for Cybernetics offers the prospect of some cooperative work on these problems. The publication of a volume on Cybernetics in the Twentieth Century Encyclopedia of Catholicism (#) offers some hope that our established institutions are starting to assimilate and adapt to new ideas in science such as the concepts of Cybernetics so that mankind can save the accumulated advances of human civilization and add to them, instead of destroying much of mankind's past achievements in revolutionary change.

January 17, 1965

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*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.

#Neville Moray, Cybernetics, Vol. 131, Twentieth Century Encyclopedia of Catholicism, N.Y.: Hawthorn Books (1963)

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b. Webster's Seventh New Collegiate Dictionary - "Comparative study of the automatic control system formed by the nervous system and brain and by mechanical-electrical communication systems."

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d. The Practical Dictionary of Electricity and Electronics, R. L. Clotfield, Chicago: American Technical Society(1958) - "The scientific study of those methods of control and communication common to living organisms and machines (esp. computers); in particular, feedback circuits and systems."

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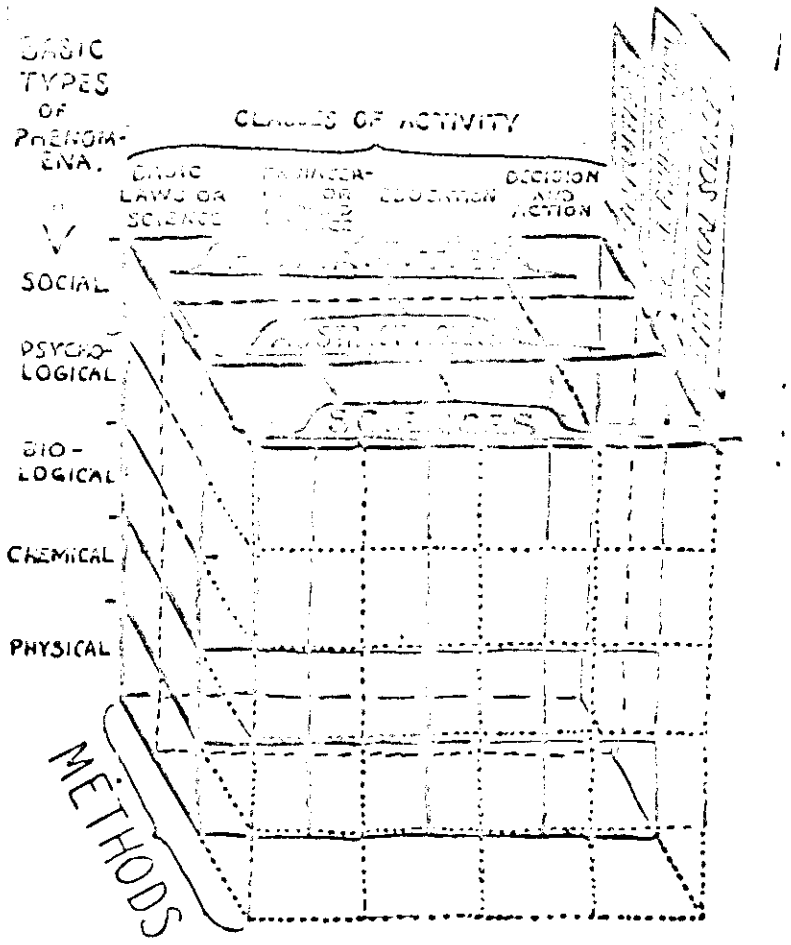
"The engines of antiquity were hardly more than ways of transmitting force.....With the advent of the heat engine in the Industrial Revolution, a very fundamental change appeared in the role of technology. Machines were now no mere transmitters of force or storers of mechanical strain: machines were now transformers of energy.....What Wiener has called the 'Second Industrial Revolution' was initiated by the appearance of machines in which the central problem became the transfer of 'information.'" (p. 1747)

* Reprinted by Four Wells, c/o C. R. Keep, Jr., 74 Lawrence Hill Rd., Huntington, Long Island, N.Y. (1963), paper $8.00

13. The assignment of space in this imaginary skyscraper is based on the following diagram from F. O. Wood, "A General Systems Theoretic Model for the Estimation of the Negentropy of Sociological Systems through the Application of Two Isomorphic Electrical Communication Networks," First International Congress of Social Psychiatry, London, August 1964.



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Date: 6/14/64 9/12/64 1/17/65 5/8/65

Stage: G References Added Revisions H

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