SEPR No. 211-B
October 9, 1969

Outline and Reference Notes for a

Workshop on

"Cybernetic Aspects of Social and Technical Processes that Endanger the Ecological Balance,"

Society for Social Responsibility in Science

Annual Meeting

October 17-19, 1969

New Haven, Connecticut

Abstract

The hazards to the balance of the ecology of our planet due to radioactive fallout, non-degradable detergents, smog, increased carbon dioxide in atmosphere, tetraethyl lead contamination of the earth, and others are discussed by Dr. Barry Commoner in the book, Science and Survival (N.Y.: Viking, 1966). As each specific hazard to the ecological balance becomes known, people start looking for solutions to the specific problem, and then the next problem becomes significant.

The purpose of this workshop is to explore whether we can develop a more general perspective of the processes, both technological and sociological, that contribute to these unbalances. As a start we shall examine curves of world power production and curves of world population growth to see if there are potential analogies with positive or negative feedback processes of cybernetics that might give us better insights into the problem. Then we shall examine at one level finer detail in regard to social evolution, and also biological evolution, to review how the ecological balance was restored through the demise of previous civilizations which started to run out of control.

Next we shall examine some concepts from cybernetics and information theory that might help us measure the degree of unbalance of our general system. Then we will examine how we can test such hypotheses which cut across many different disciplines of science. This may lead to ideas on how to provide the additional feedback loops in our sociological system that are needed to keep our ecological system in balance.

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List of Specific Factors Contributing to Ecological Unbalance

1. Non-degradable detergents(problem now reasonably solved by development of bio-degradable detergents)

2. Phosphates and nitrates in water supply(specific problems require basic agricultural research)

3. Carbon dioxide in atmosphere may cause temperature rise in time that could melt the polar ice-caps.

4. Smog due to internal combustion engines.

5. Radioactive fallout.

6. Pesticides.

7. Annihilation from nuclear war.

The above specific problems are discussed at length by:

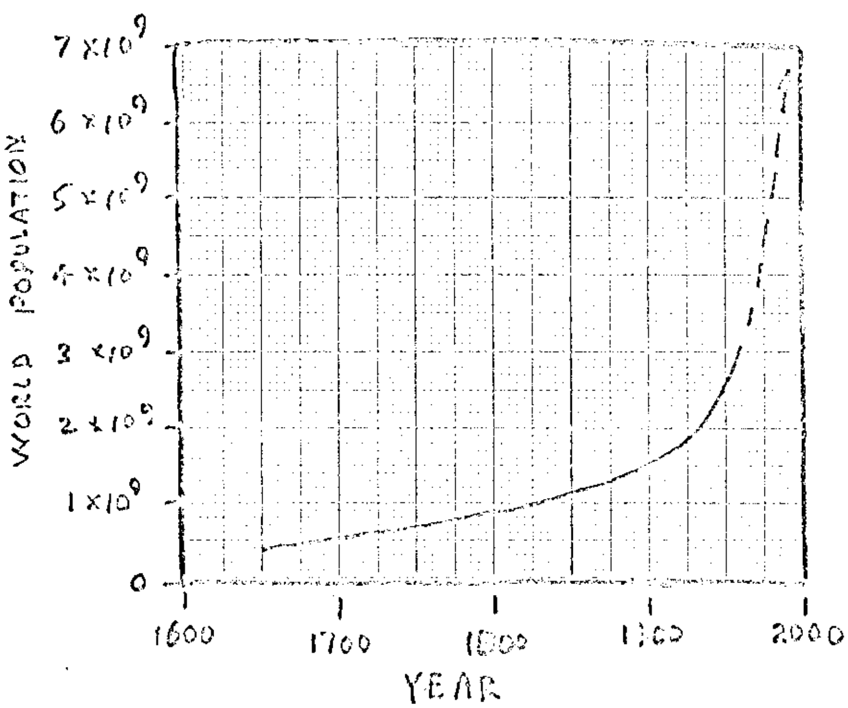
Dr. Barry Commoner in Science and Survival, N.Y.: Viking(1966).

There is another approach to listing problems and crises of our civilization, namely a two-dimensional chart in which the x-axis is the time left until the problem becomes critical, and the y-axis is the crisis intensity. Work along this line has been done by Dr. John Platt at the Mental Health Research Institute, University of Michigan. One could inquire of MHRI, if such analyses have been published yet.

World Population Growth

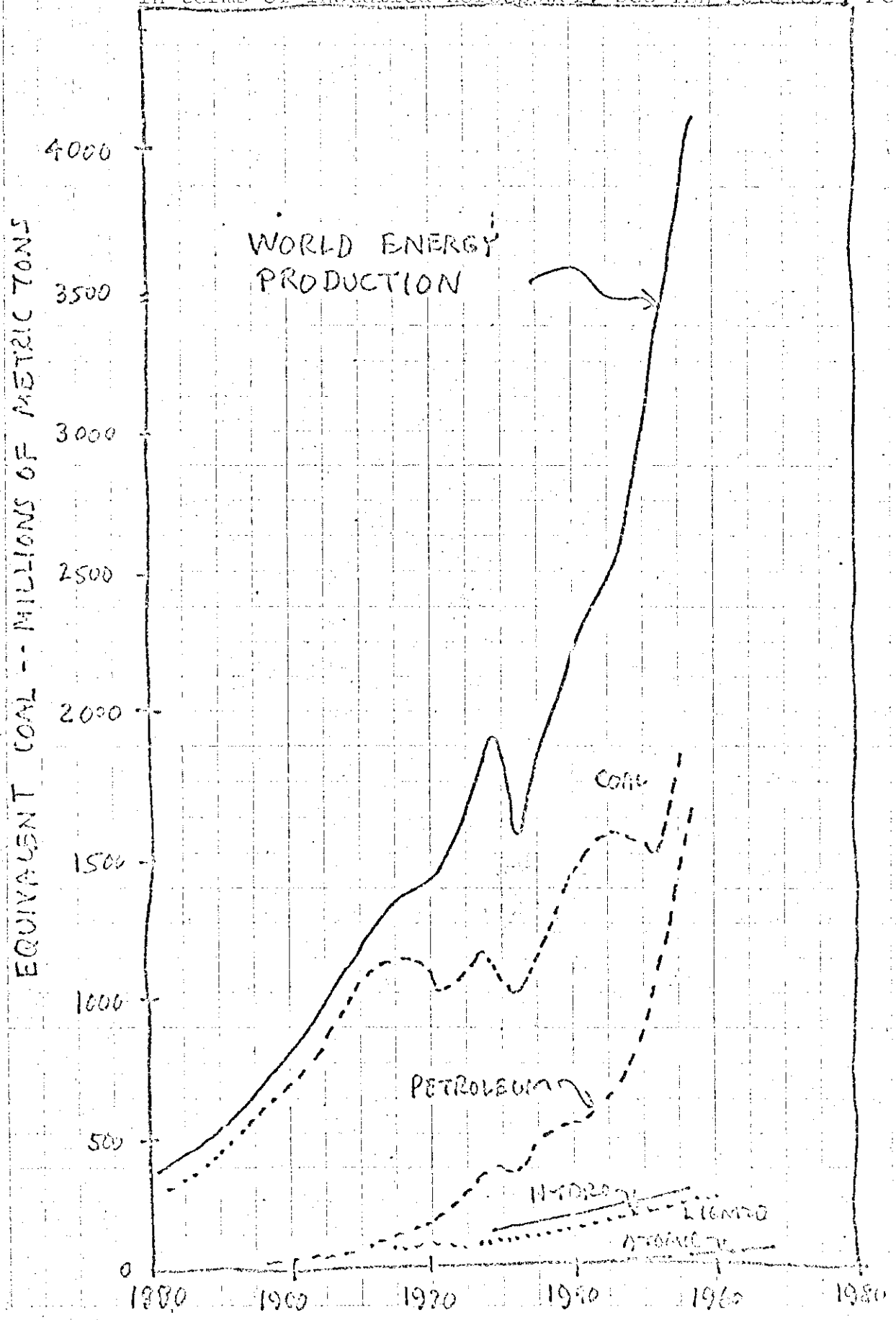
For a more complete plot of world population growth, see:

George Borgtrom, "The World Food Crisis." FUTURES, June 1969, pp. 339-.



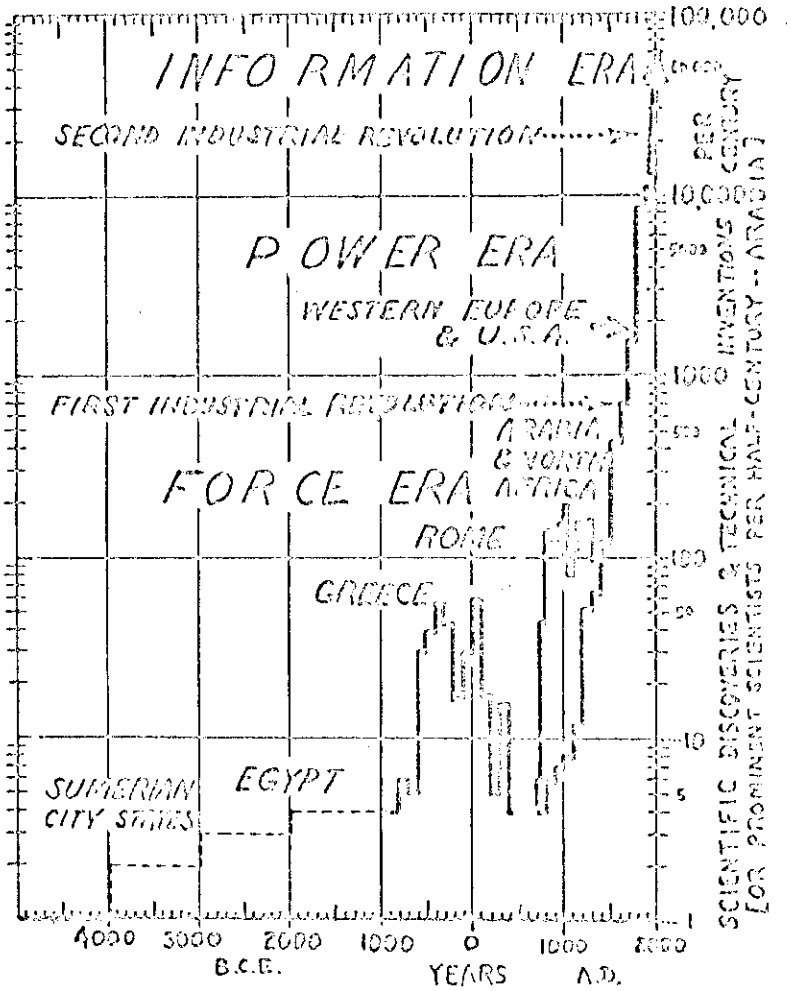
World Power Production

These curves are extended from League of Nations, and World Power Conference Reports. For curves for the United States in terms of installed horsepower, see THE FUTURIST, Feb 1969, p. 23.



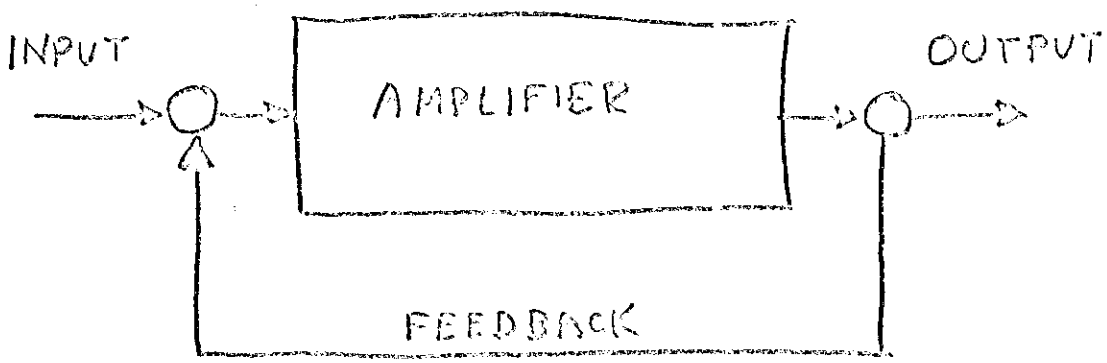
Historical Trend of Number of Scientific Discoveries and Technological Inventions Per Century.

To assist us in determining under what conditions the study of CYBERNETICS becomes essential for the understanding and resolution of social problems, I have plotted the number of scientific discoveries and technological inventions by century from 5000 BCE to 1969 AD. For Greece and Rome and Western Christian Civilization, I have used tables from P. A. Sorokin. For Arabia, I have used a count of the number of prominent scientists per half-century from Sorokin's interpretation of data from Sarton. For the time before Greece, I was not able to find data, so as a first approximation, I have extrapolated the trend backwards in time to the level of one invention per century.

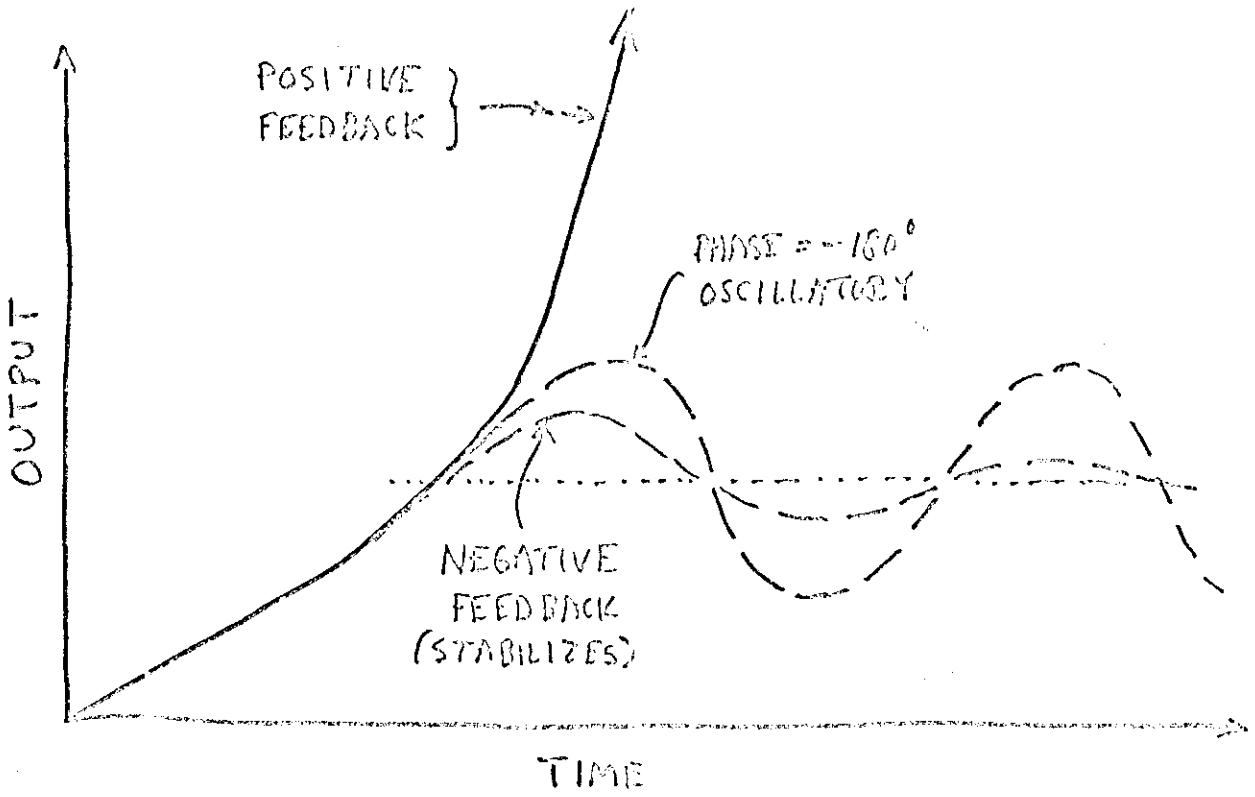


The source tables are from P. A. Sorokin, Society, Culture, and Personality. N.Y.: Harper(1947), pp. 664-665. The transitions, marked "First Industrial Revolution," and "Second Industrial Revolution," are described by Anatol Rapoport, "Mathematics and Cybernetics," in Silvano Arieti, editor, American Handbook of Psychiatry, N.Y.: Basic Books(1959), Vol. Two, pp. 1743-1759(Chap. 87).

Cybernetic Feedback Amplifier



Positive Feedback, Negative Feedback, & Oscillatory Condition



Analogies between Cybernetic Feedback Systems and the Curves of Population Growth, World Power Production, and Scientific Discoveries.

How valid are comparisions of these curves of characteristics of social systems with electro-mechanical feedback systems?

Did the fall of Greece and also of Rome serve a purpose in maintaining the ecological balance?

Is our civilization the first major civilization to have the capability to prevent our downfall?

Can we find some philosophical concepts that cut across physics, chemistry, biology, and sociology that could give us a better perspective of the technical and social processes?

To be more specific, are there preferred choices of coordinate systems for representing the periodic table of physics and chemistry; the evolution of biological species; and the evolution of social systems---
---which would give us better insights into the host of problems disturbing the ecological balance on our planet?

For example, if the periodic table of the elements, some chart of biological evolution, and charts of social evolution could all be put into the same format, we might have more confidence that there are similar rules of development in these three different levels of natural phenomena.

A sociologist, Dr. Stuart C. Dodd, has developed a method of Epicosm Modeling which through a probabilistic process generates a series of constants related to eight levels of the cosmos: entropy, gravity, energy, matter, life, man, society, and science. So far no rigid method of testing Dr. Dodd's hypotheses has been developed that meet the standards of normal scientific research. If we knew how many other planets in the universe support living beings, we would be able to check the validity of the right hand line of his mass-triangle in his Report EpiDoc #126. (*)

* S. C. Dodd, "How Epicosm Modeling Studies the Cosmos As the Whole Set of Actant-Elements Interacting in Time."EpiDoc #126, SD: 67-38A, Proj. Epicosm, Univ. of Washington, Seattle, Washington 98105, Dec. 1967. (Earlier versions of this material were presented by S. C. Dodd at the annual meetings of the Society for General Systems Research in Dec. 1964 and Dec. 1965.

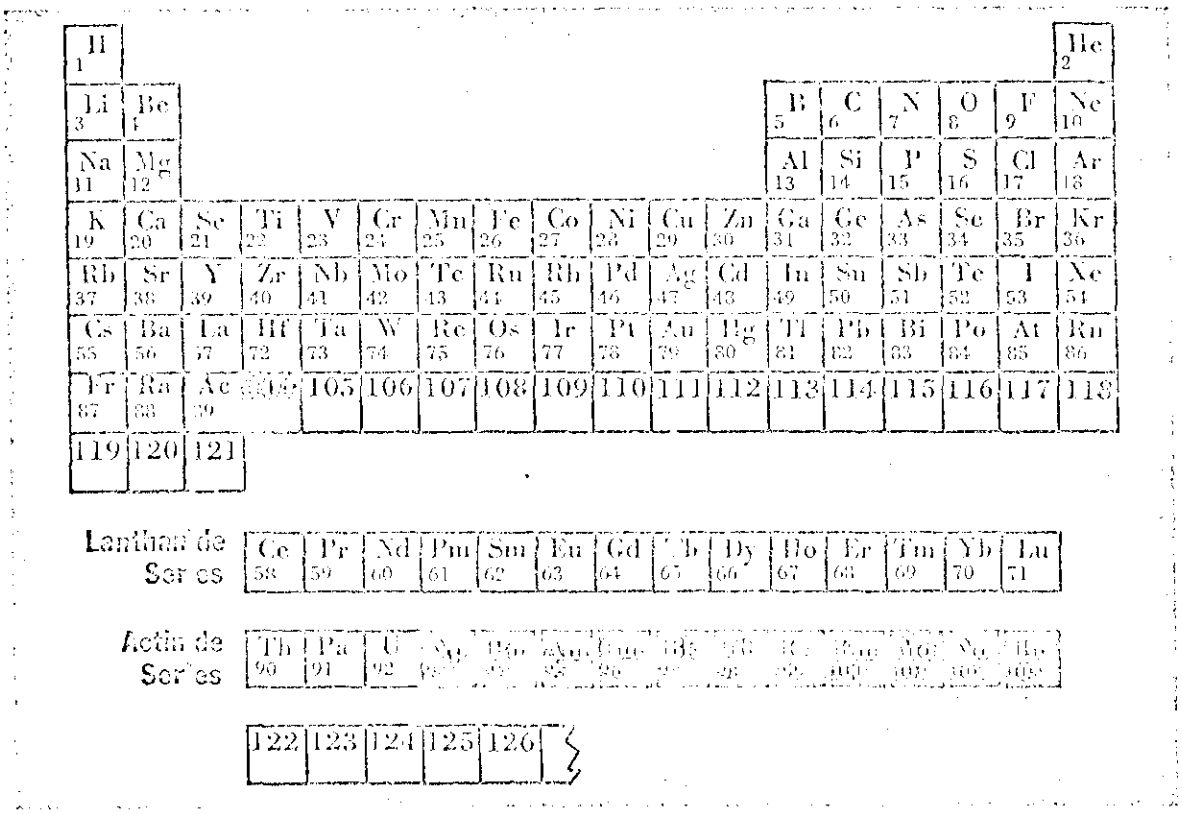
In this workshop, we are not prepared to test Dr. Dodd's unverified hypotheses. The usefulness of the Epicosm models here is more an inspiration to help our search for less comprehensive models that might help us in our study of ecological unbalance.(To test the Epicosm models we need (1) a better understanding of the nature paradigms in scientific revolutions, and (2) a better understanding of the principles of duality in physics, information theory, computer science, sociology, and philosophy.)

What choices do we have in arranging the elements of physics and chemistry in a periodic table?

(from SEPR No. 179-A, 5/26/68)

The periodic table of the elements has been organized into many forms: rectangular, circular, spiral, triangular, open jaw, and spiral on the surface of a cone, and matrix.

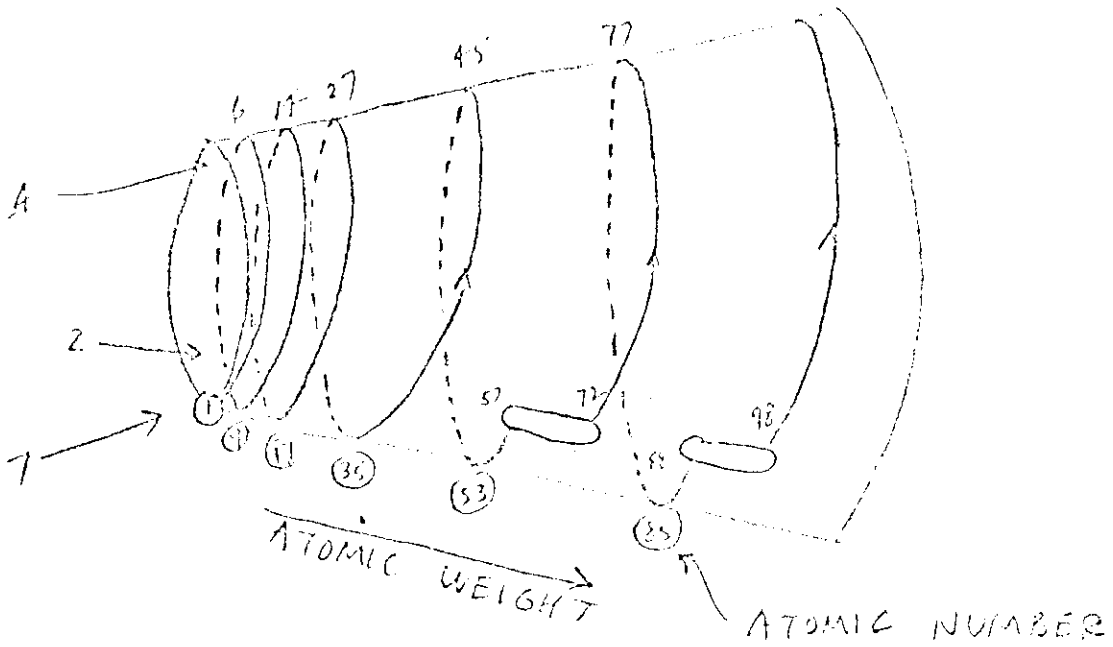
Changing the form of the periodic table doesn't contribute anything new in chemistry. Some forms of the periodic table are more convenient for looking at certain problems.
The standard form(from Chemistry, Vol. 39, No. 11, p. 22, Nov. 1966) is shown below:



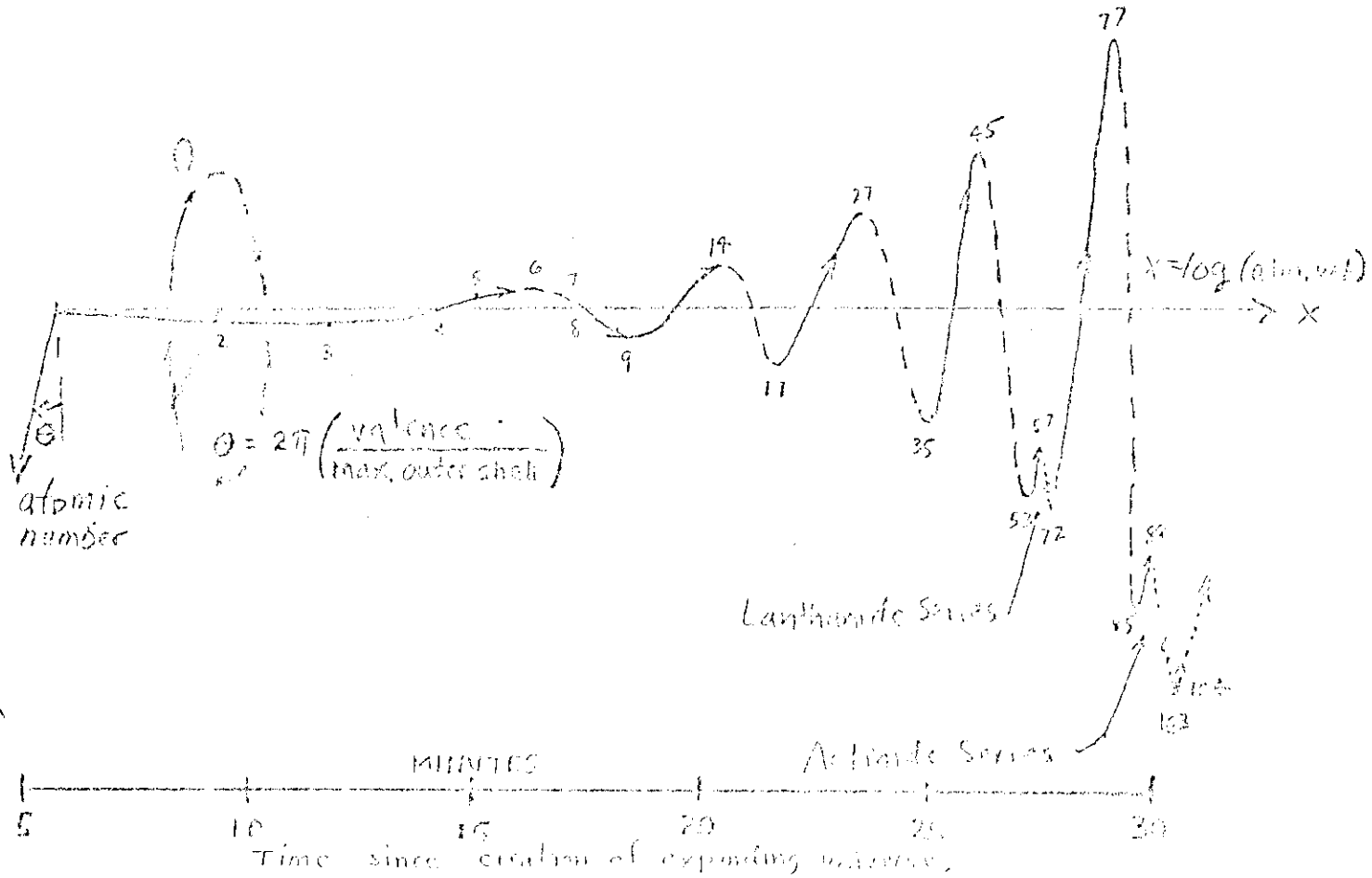
S. I. Tomkieff in A New Periodic Table of the Elements, London: Chapman Hall(1954) proposed a spiral form of plotting the periodic table. Other forms and variations of the spiral periodic table have been discussed by: (courtesy of IFR)

Janet, Chemistry, vol. 39, no. 7, p. 10, July 1966.
Theodor Benfey, Chemistry, p. 14, june 1964.
E. G. Mazurs, Chemistry, "The Ups and Downs of the Periodic Table," vol. 39, no. 7, pp. 6-12, July 1966.

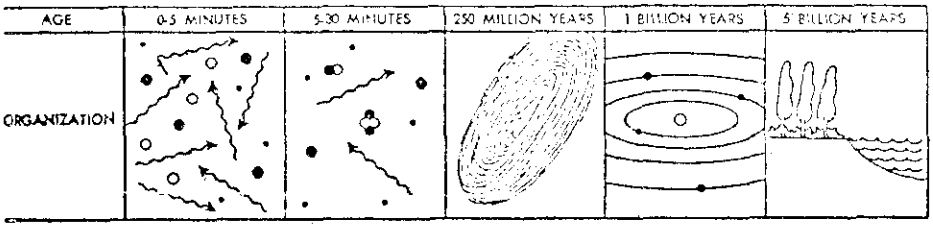
Tonkoieff's version of the periodic table is sketched below:



If we change the coordinates as follows, we get the spiral form shown below. X-axis proportional to logarithm of atomic weight. Radius proportional to atomic number. Angle corresponds to fraction of 2 pi radians proportional to valence divided by number of electrons in outer shell.



The estimated time scale of 5 to 30 minutes at the bottom of the spiral periodic table is a first approximation to the time of creation of the different elements based on Lemaitre's theory of the expanding universe. A short summary of the evolution of the universe is reproduce below from Georg Gamow's chapter in Milton K. Munitz, editor, Theories of the Universe, Glencoe: The Free Press and the Falcon's Wing Press(1957), p. 399. (From Scientific American, March 1954, pp. 55-63.)



Evolution of the Universe is symbolized at five stages. During the first five minutes of its expansion photons (*wavy lines*) outweighed solitary particles of matter such as protons (*black circles*), neutrons (*larger white circles*) and electrons (*smaller white circles*). Between five and 30 minutes matter had gained the upper hand and the fundamental particles had begun to coalesce into more complex nuclei such as those of deuterium (*proton and neutron*) and helium (*two protons and two neutrons*). After 250 million years the primordial gas began to break up into huge protogalaxies. After a billion years the matter in the protogalaxies had condensed into stars and planets. The present epoch is characterized here by the presence of life on at least one planet.

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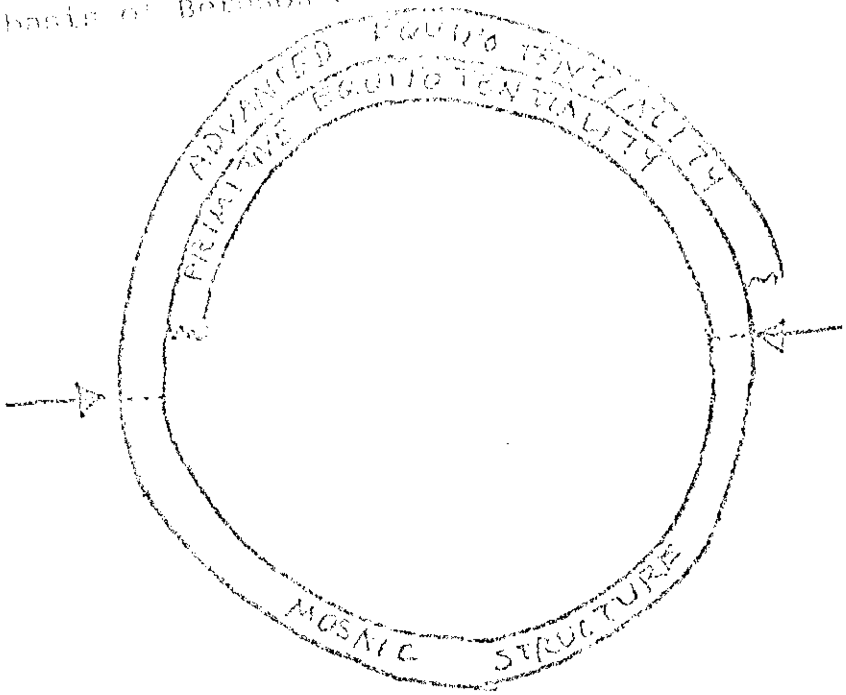
Is there a preferred system of coordinates in which to plot the characteristics of biological evolution?

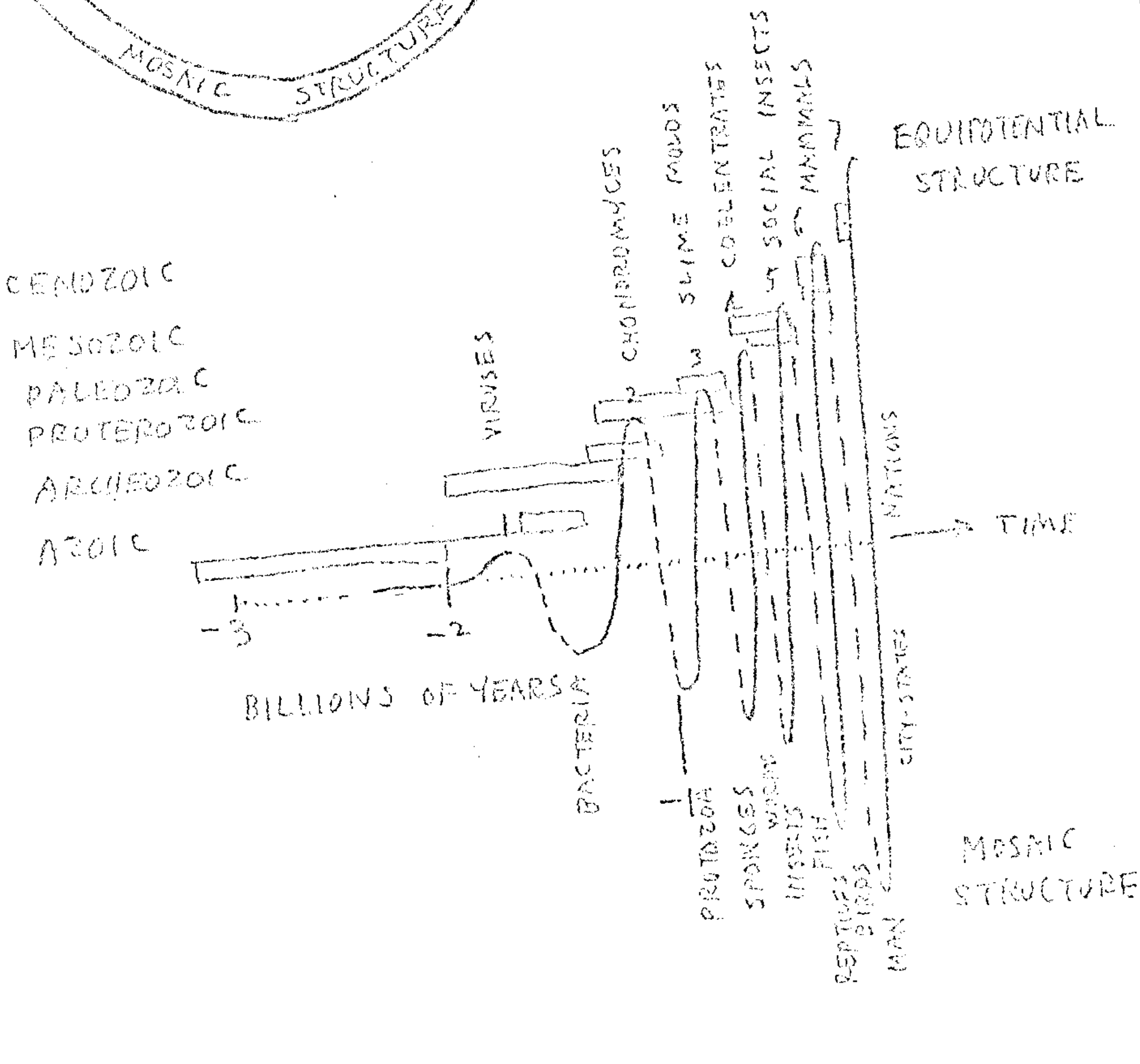
On January 5, 1968, Bryan P. Bergson gave a paper at the Bay Area Systems Group of the Society for General Systems Research in San Jose on "Equipotentiality In A General System." He developed a frame of reference for examining biological systems in which there is an evolutionary development from equipotential to mosaic to equipotential on a higher level. The various life forms were classified within this frame, where periodicity of function analogous to the periodic chart of chemical elements is demonstrated. Societies of man, as biological phenomena, occupy logical positions relative to other life forms, and characteristics of these societies become predictable.

Unfortunately Mr. Bergson's full theory has never been published. However a report summarizing his theory has recently become available.(*)

*Bryan P. Bergson, "The Theory of Socio-Metabolic Transition." Pamphlet, September 21, 1969, 4pp., B. P. Bergson, 15000 Jeanette Lane, San Jose, Calif. 95127.

The strip illustration from [illegible]'s paper is reconstructed below in the spiral form. On the bottom of the page the full spiral of biological-social evolution is reconstructed on the basis of Bergson's theory of the socio-metabolic transition.





Comparing the resultant curve for biological evolution using Bergson's definition of coordinates, we note a similarity with the form of the special arrangement of the periodic table of the chemical elements on page 8. For this similarity of form to be of significance, we must find ways to test the validity of Bergson's theory of the socio-metabolic transition.

Since these concepts have not been communicated widely enough to get sufficient criticism to determine their usefulness, the first test we can develop is to compare curves of empirical data from sociological studies with the latest cycle in the spiral of biological-social evolution.

A sample curve is reprinted below from Pitirim A. Sorokin, Society, Culture and Personality: Their Structure and Dynamics. N.Y. Harper &Bros(1947).

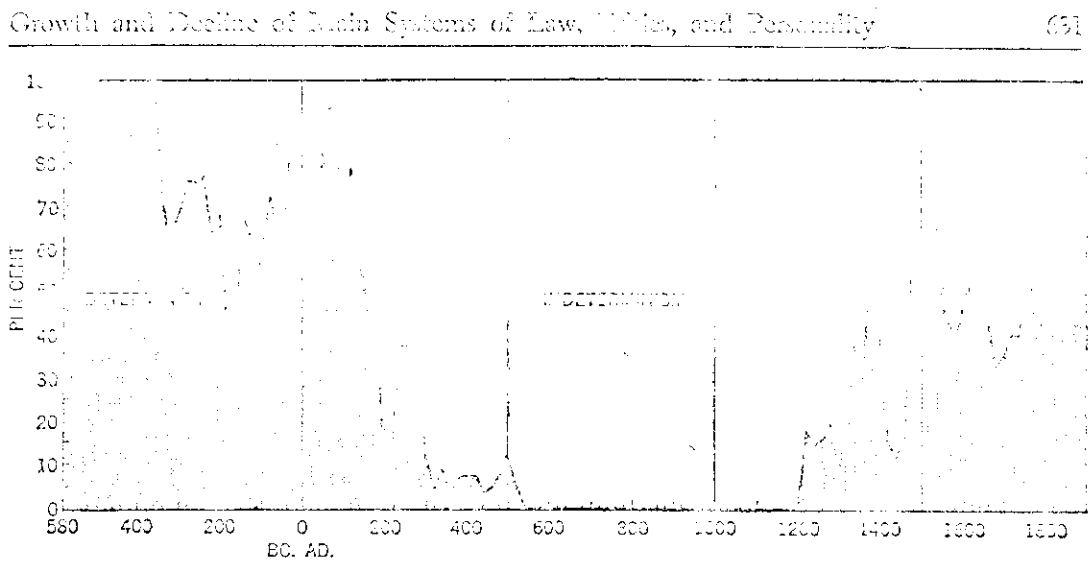


Figure 16. Movement of Deterministic and Indeterministic Philosophies, 580 B.C. to 1900 A.D.

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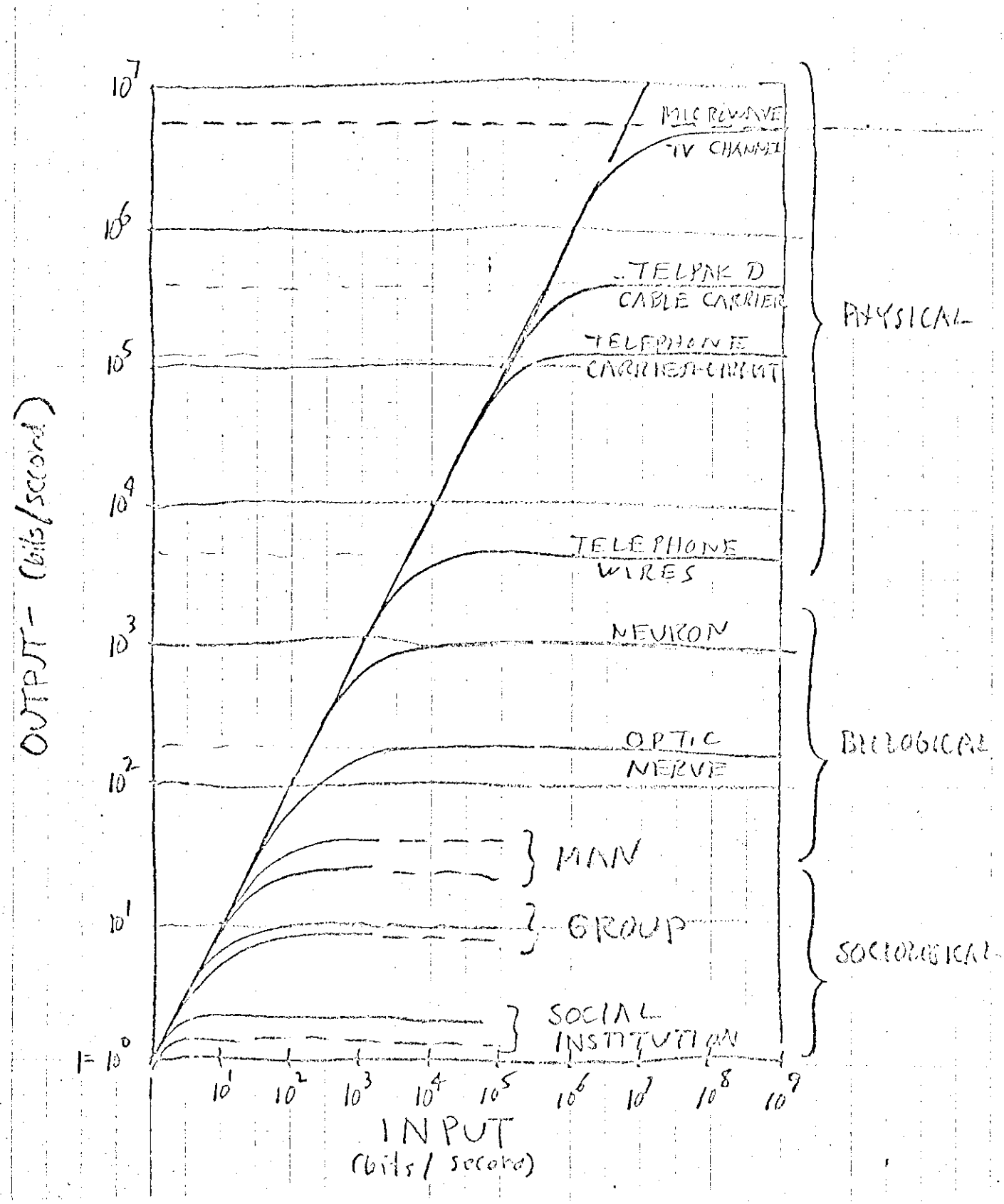
An important question to examine is whether curves like the above might be projections on a two-dimensional plane from a three-dimensional spiral curve of social evolution.

If we are going to try to use the analogy of the form of evolutionary development that is similar in physics-chemistry and biology-sociology, we must also find some more detailed structure to relate or compare similar phenomena in the different fields of science. To start on this process, curves of information output versus information input rate (bits/second) are plotted for some typical physical, biological, and sociological systems on the next page.



Channel Capacities of Physical, Biological and Sociological Systems.

Can we use a parameter such as "entropy" to measure whether features of physical, biological, and sociological evolution are improving stability of the ecological balance?

In the past twenty years, it has become popular to apply measures of entropy to many varieties of phenomena.

In a reprint of mine, SEPR No. 139-D, "A Reprint of Three Notes On The Use Of Cybernetics To Solve Social Problems," I give some examples of how to use the concept of entropy in analysing certain sociological problems.

In the book, Biological Order, MIT Press (1962), Andre Lwoff questions the validity of the use of negentropy as a measure biological evolution.

I propose the following chart as a first approximation to resolving disputes as to proper application of entropy-like measures:

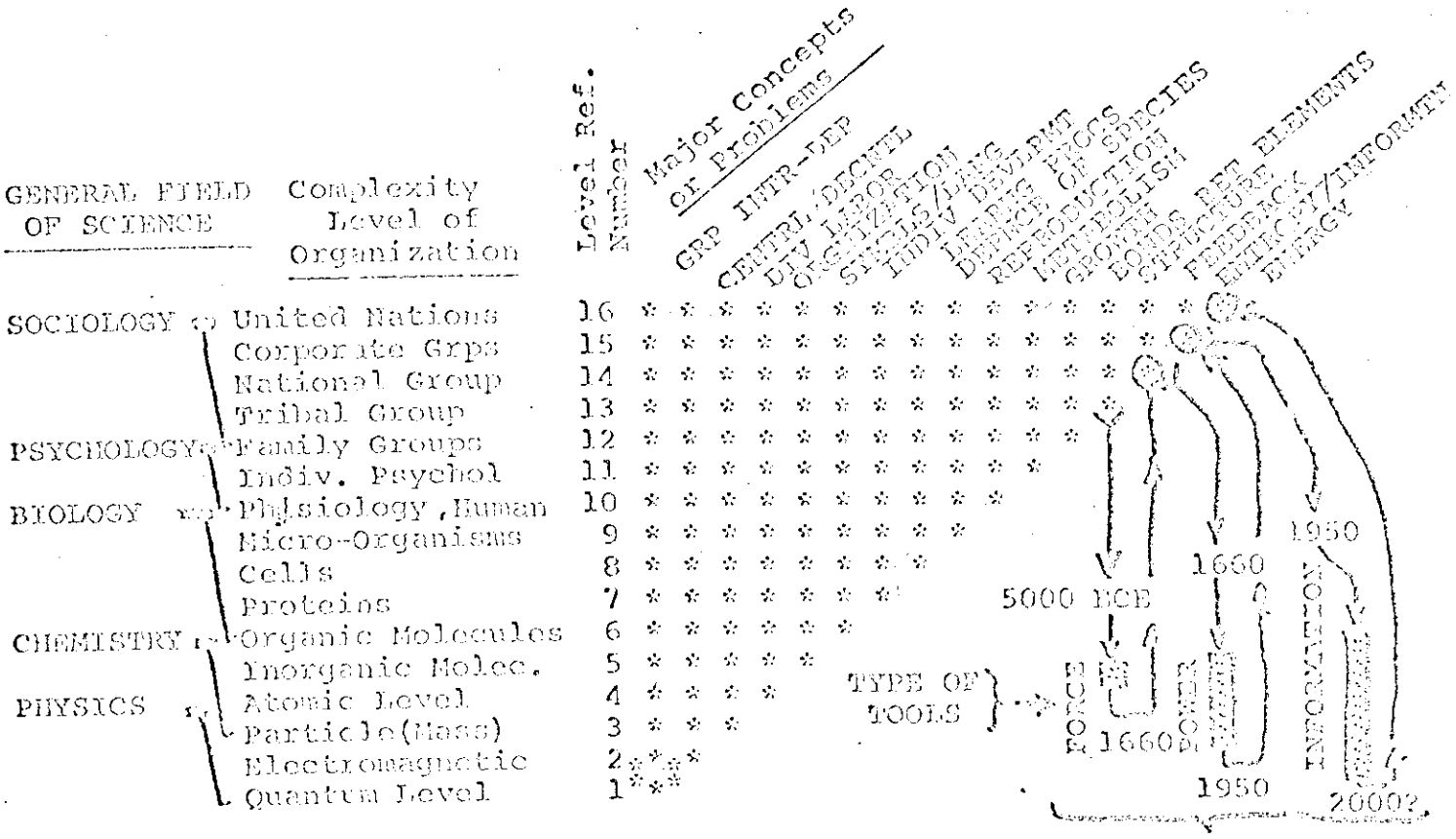


Fig. 1 - Levels of Organization on the Planet Earth, Related Fields of Science, and Related Technological Eras in Man's Development.

The significance of this chart is that there is a direct equivalence between information and entropy only at the quantum level(level 1 in the chart). At the higher levels there are "entropy-like" properties which may have identical mathematical form to "entropy-like" properties at another level. It appears that use of the negentropy or "entropy-like" property at level "n" is valid only when one has some knowledge of the other "n-1" properties.

Since this paper was prepared for the purpose of introducing some ideas for the workshop, it is terminated at this point as an incomplete paper. The blank section below symbolizes the work yet to be accomplished through the discussions of this workshop:

10/18/69	Distributed to participants of Workshop at Society for Social Responsibility in Science Conference, Yale University, New Haven, Conn.
10/30/69	Minor corrections made in text of notes.