Third Order Cybernetics: Biosemeosis and the Logical Contrasts between Electro-chemical and Electro-mechanical Cybernetics.

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The steerage of large systems operates through local feed back and feed forward dynamics. My focus will be on the formal distinctions between electro-mechanical cybernetic systems, such as those of Weiner and electro-chemical cybernetic systems described empirically in molecular biological, biological and social-cultural systems. Electro-mechanical cybernetic systems will be distinguished from electro-chemical cybernetics systems on the basis of the differences in the nature of the logic and of the mathematics of the feedback and feed forward processes.

In simple electro-mechanical systems, the information necessary for steerage is encoded into mathematical abstractions and fed into the system as algorithmic commands that direct the operations of the system. The energy necessary to operate an electro-mechanical system is supplied by an independent external source. The electro-mechanical system is poised to interpret the code and implement the directions. Communications between the message giver (steerer, cybernetician), and that which is to be steered and the implementation of the steerage operations are managed by a clock. The clock functions to coordinate the multiplicity of local processes such that steerage aims toward the design goals of the system. The designer plans the purpose or the final cause of the electro-mechanical system with algorithmic intent. For simple systems, human intervention is required periodically for system maintenance and repair.

Like simple electro-mechanical systems, electro-chemical systems also operate through local feed back and feed forward systems. While the steerage principles of electro-mechanical and electro-chemical systems are described by the same logical terms, feedback and feed forward, the formal logic of the two sorts of systems differ by the nature of the codes used to communicate information among the different sorts of components of the two sorts of systems. Electro-mechanical systems are usually designed to be controlled by codes expressed in terms of strings of zeros and ones within the formal logic of Boolean algebras. Natural electro-chemical systems (of various sorts - chemical, biological and social) are encoded in the powerful physical code of the atomic numbers. The natural designs implemented within the atomic numbers has, apparently, the intrinsic capacity to articulate the functions of design, implementation, clocking, coordination, and of maintenance and repair within the formal diagrammatic logic of the operating system. Some elements of this diagrammatic logic were constructed by C S Peirce (1839-1914), other elements are closely related to modern category theory (Ehresman and Vanbermeersch, 2008), and yet other elements from empirical observations of physics, chemistry, genetics and molecular biology.

The rudiments of the mathematics of simple electro-chemical systems follow from the number of generating functions necessary to construct the natural categories (sorts of internal structures.) The reference system for constructions of systems is the interrelationships of electrical particles (Moseley's "atomic number" as internal parity within the concept of a number-structure) and the principle of conservation of matter Addition of parts to make a whole is the principle route of construction. Euler's generating function generates all possible additive combinations of number-structures. All constructions are based intrinsically within diagrammatic logic. The internal forms of the number-structured diagrams serve multiple functions that convey a message as a structure. The encoding of messages is based systematically on heritable precedents.

Several constructional differences separate the scientific logic of the electro-mechanical cybernetics from electro-chemical cybernetics. These logical distinctions separate the symbolic logic of cybernetic operations into two distinct symbol systems.

Mathematics (1) order
Electro-chemical order of symbols requires internal structures for numerals
Electro-mechanical order requires geometric regularity of a line.

Mathematics (2) illations
Electro-chemical illations require logical operations on graphs
Electro-mechanical illations require arithmetic operations on objects as lines or related objects.

Mathematics (3) sets
Electro-chemical illations operate on multi-sets.
Electro-mechanical relations are interpretations of set theory

Mathematics (4) diagrams
Electro-chemical relations based on illations among additive graphs.
Electro-mechanical cybernetics focuses on Boolean algebra.

Mathematics (5) causality
Electro-chemical cybernetics is based on material causality
Electro-mechanical cybernetics is based on efficient causality

Physics:
Electro-chemical physics based on physical identity of each chemical element.
Electro-mechanical physics based on the mechanical generation, transmission, and recording of electrical signals.

Chemistry:
Electro-chemistry includes the structure of individual atoms and molecules as patterns of electrical particles as well as the encoding of messages into such patterns.
Electro-mechanical designs use chemical objects (materials) to generate, transport and record messages encoded into abstract "bit" strings.

Biology:
Electro-chemical biology uses electro-chemical codes as “signs” to encode the entailment illations among molecules.
Electro-mechanical biology finds applications is various prosethic devices.

Evolution / Emergence:
Electro-chemistry is based on the patterns of emergence from atoms to molecules.
The feedback-feedforward relations of life are all electro-chemical in nature.

Feed forward:
Electro-chemical cybernetical systems are encoded as structural feed forward systems with the goal of reproduction of a similar system (offspring).
Electro-mechanical cybernetical systems are encoded to use external energy to progress through algorithms with defined start-stop rules.

These are some of the contrasts between electro-chemical and electro-mechanical cybernetical systems.

A sketch of the formal logic for the electro-chemical systems was proposed in “An Introduction to the Perplex Number System”, Discrete Applied Mathematics, 2009.

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