

CYBERNETICS- THE NEW ERA ARRIVES

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Abstract

The paper basically deals with the study of Cybernetics I, the history of evolution of this theory of this cyborg technology from the base to planting its roots in the future. The paper also presents a brief description about the use of this cyber technology in various fields known to the human world. Along with this is a description about the evolution of cybernetics as a cure to various medical problems.

INTRODUCTION

Cybernetics is basically and most popularly known as art of steering. Correctly speaking it is the science of communication and control theory that is concerned especially with the comparative study of automatic control systems. Cybernetics treats not things but ways of behaving. It does not ask "what is this thing?" but "what does it do?" and "what can it do?". Cybernetics cuts across many traditional disciplinary boundaries. The concepts which cyberneticians develop thus form a metadisciplinary language through which we may better understand and modify our world. Cybernetics as a process operating in nature has been around for a long time. Cybernetics as a concept in society has been around at least since Plato used it to refer to government.



WHAT DOES IT REALLY MEAN

A. History

The history of cybernetics started after the World War II. Between 1946 and 1953 the Josiah Macy, Jr. Foundation sponsored a series of conferences in New York City on the subject of "Circular Causal and Feedback Mechanisms in Biological and Social Systems." The basic concepts of cybernetics are negative feedback and information. A famous example of negative feedback is given by Watt's governor, the purpose of which is to maintain the speed of the wheel of a steam engine, at a given value, despite perturbations. The theory of information, mainly due to

Claude E. Shannon, gives a measure of the unexpectedness of a message carried by a signal.

Cybernetics began properly with the publication, in 1948, of a book by Norbert Wiener entitled "Cybernetics or Control and Communication in the Animal and the Machine". The word cybernetics had been chosen by Wiener, in agreement with other colleagues, from the Ancient Greek *kubernetike*, or the art of steering. Another initiator, almost as important as Wiener, is Warren S. McCulloch who published, in 1943, in collaboration with N. Pitts, an article on logics and the nervous system. The directions of approach of Wiener and McCulloch were different—Wiener saw Leibniz as the historical patron of cybernetics, whereas McCulloch was inspired by Descartes. Wiener's preference was due to Leibniz's interest in the construction of a calculating machine, and his attempt to build up a general calculus of logics (calculus ratiocinator). Contrastingly, McCulloch observed that Descartes, in his treatise on man, had introduced negative feedback in his description of how an individual escapes the inconvenience of a fire close to his foot. Incidentally, this would seem to show that it is wrong to see Descartes as a promoter of a reductionism based upon decomposition into material parts. Here the kind of reflex arc seen by Descartes is of a holistic conception. In fact Descartes only recommends decomposition of logical difficulties into parts.

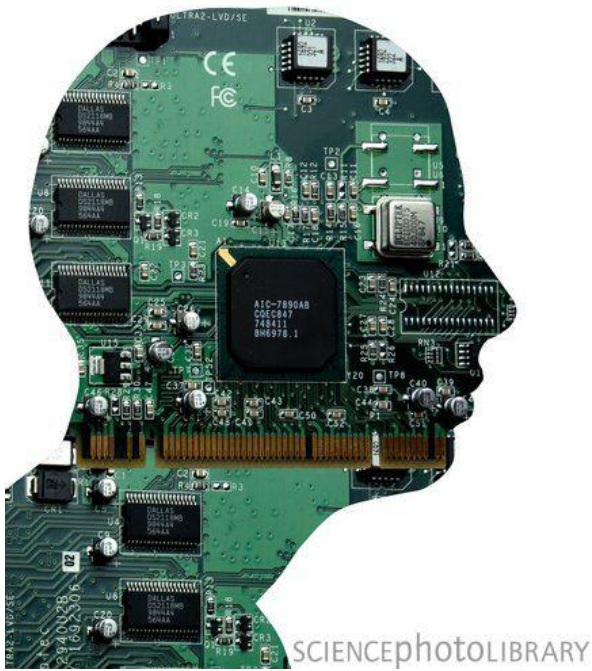
It may be of interest to note that J. von Neumann also had contact with Wiener and McCulloch, mainly in a group sponsored by the Macy Foundation called the Teleological Society, or informally the "Cybernetic Club", to which H. von Förster also contributed. Other associations also devoted to cybernetics included the Cercled'EtudesCybernétiques in France, and the Ratio Club in Great Britain.

Other initiators to be covered in more detail below are Claude E. Shannon and William Ross Ashby. The importance of Shannon, for his essential contribution to communication theory, was recognized by Wiener himself. The eminent role of Ashby had more to do with control seen from the point of view of "requisite variety". Other contemporary initiators were P. Vendryès, with his early theory of autonomy, S. Odobleja, and P. Postelnicu who understood the general role of retroaction. H. Schmidt also deserves special

mention for his introduction of a "general science of regulation loops", as does J. Lafitte who recognized the interest of what he called "reflex machines".

AI AND CYBERNETICS

Ironically but logically, AI and cybernetics have each gone in and out of fashion and influence in the search for machine intelligence. Cybernetics started in advance of AI, but AI dominated between 1960 and 1985, when repeated failures to achieve its claim of building "intelligent machines" finally caught up with it. These difficulties in AI led to renewed search for solutions that mirror prior approaches of cybernetics. Warren McCulloch and Walter Pitts were the first to propose a synthesis of neurophysiology and logic that tied the capabilities of brains to the limits of Turing computability [McCulloch & Pitts 1965]. The euphoria that followed spawned the field of AI [Lettvin 1989] along with early work on computation in neural nets, or, as then called, perceptrons. However the fashion of symbolic computing rose to squelch perceptron research in the 1960s, followed by its resurgence in the late 1980s. However this is not to say that current fashion in neural nets is a return to where cybernetics has been. Much of the modern work in neural nets rests in the philosophical tradition of AI and not that of cybernetics.



Cybernetics went into eclipse in the 1960s; AI came to the fore and stayed there. There are basically four possible reasons for that-

1. Multidisciplinary. Cybernetics was conceived from the start as a multidisciplinary project, taking in mathematics, computing, engineering, social sciences and the humanities. Although we'd all probably agree that, in theory, this is an excellent approach to such a challenging problem as understanding intelligence and replicating it in machines, it was probably hard to sustain in the research environment of the time.
2. Theoretical aims. Cybernetics' central aim was understanding. There was less emphasis on building useful intelligent artefacts. AI promised immediate delivery of working intelligent systems, and produced some impressive and encouraging early results.
3. Technology. The computing technology of the time may have been too weak to be an adequate vehicle for cybernetic systems.

Competition for funding. In the 1960s, as now, competition for research funding was intense. There may also have been personal animosity between

cyberneticists and Symbolic AI researchers. In 1969 the noted scientists Marvin Minsky and Seymour Papert published *Perceptions*, a devastating critique of certain computational models of nervous systems, which showed, with unanswerable mathematical arguments, that such models were incapable of doing certain important computations. Perceptrons killed most research into neural computing for fifteen years.

PRINCIPLES OF CYBERNETICS

The Principles or laws play the role of expressing the most basic ideas in a science, establishing a framework or methodology for problem-solving.

Principles of Cybernetics

- The principle of homeostasis
- The principle of external completion
- The principle of requisite variety
- The principle of feedback
- The principle of intentionality

The domain of General Systems and Cybernetics is in particular need of such principles, since it purports to guide thought in general, not just in a specific discipline. Unfortunately, the few generally used principles of the domain, such as the law of requisite variety, or the principle that the whole is more than the sum of its parts, are typically ambiguous or controversial, and lack coherence with each other. The principles should have the following properties-

Primitive:

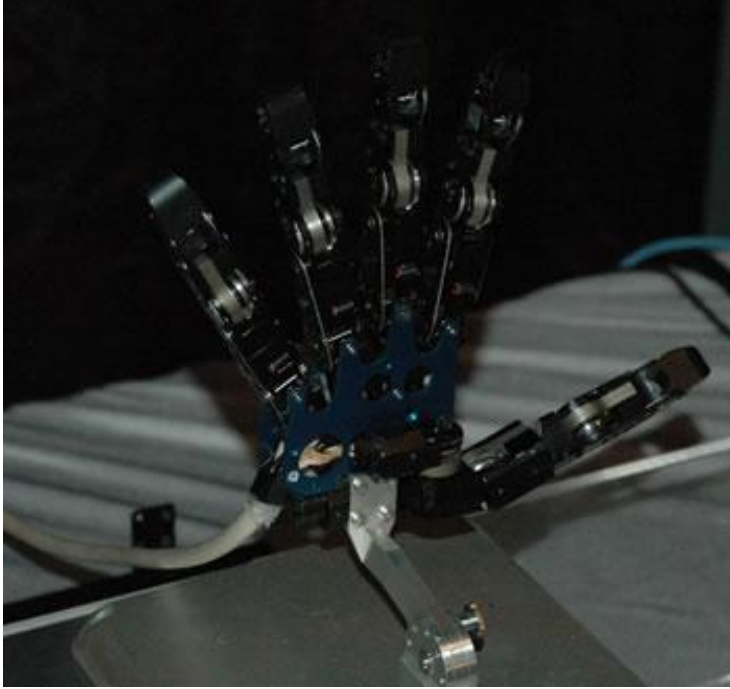
The word "principle" is derived from the Latin *principes* (he who goes first) or *primo* (first). Principles are primary or primitive in that something can follow *from* them. They are the *beginning* to a system of thought, axiomatic (although we want to avoid the formal sense of that term).

Simplicity:

Principles should be simple almost to the point of being self-evident or tautological.

Universality:

Principles should have virtually universal applicability within the domain of Cybernetics and Systems Science.



- **In Engineering.**

Cybernetics in engineering is used to analyze cascading failures and System Accidents, in which the small errors and imperfections in a system can generate disasters. Engineering cybernetics (or Technical cybernetics) deals with the question of control engineering of mechatronic systems. It is used to control or regulate such a system; more often the term control theory encompasses this field and is used instead. See the FIG2.7.1 of Artificial Heart, which is the example of biomedical engineering object.



VARIOUS AREAS OF CYBERNETICS

- **In complexity science**

Complexity Science attempts to analyze the nature of complex systems, and the reasons behind their unusual properties.

Cybernetics becomes a way of modeling Complex Adaptive System.



national, national, European, international) and indifferent sectors (including the private, semi-private and public sectors; the latter sector is emphasized

- **In Psychology**

The word cybernetics comes from a Greek term that means 'a helmsman who steers his ship to port.' Psycho-Cybernetics is a term I coined which means, "Steering your mind to a productive, useful goalso you can reach the greatest port in the world... peace of mind. With it, you're somebody. Without it, you're nothing."

- **In mathematics**

Mathematical Cybernetics focuses on the factors of information, interaction of parts in systems, and the structure of systems

- **S/W Cybernetics**

Software cybernetics is an emerging area that

explores the interplay between software and control. Software cybernetics treat software testing as a control problem, where the software under test serves as a controlled object and the software testing strategy serves as the corresponding controller.

APPLICATIONS OF CYBERNETICS

- **Learning**

A brain comprises simple processing elements, called neurons.

Those act rather slowly. Typically brain does 1000 operations a second, whereas a computer does many millions. However, the brain has billions of neurons – connected together in a network. The net result of which is much more powerful than a normal computer.



We have seen a need for systems to learn (a process which involves feedback) - but how can this be implemented? Can we in fact produce systems that are 'intelligent'? We could use a computer, suitably programmed - which in effect has one (or a few)'processing' elements. However, even modern computers are not that advanced – perhaps it would be better to develop systems more like the most powerful learning systems - brains.

- **Virtual Reality and Human Computer Interaction**

Feedback we have seen for control and for learning. It is also used in the interaction between humans and
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machines, such as computers: human-computer interaction or HCI. In fact, when you use a mouse to position the cursor you are using feedback – you look at the cursor on the screen and move the mouse until the cursor is correctly placed -or is it that the computer moves the cursor until you have put the mouse in the right place?



Here a computer generates the necessary information so that the human can seem as if he or she is in an artificial world - i.e. the computer generates what the world looks like, perhaps sounds like, smells like and feels like (for which haptics is needed - aspeciality at Reading).But, were the human to turn his/her head, the world should look different - so the computer has to generate a new image of the world.

- **Cybernetics and the environment**

We have seen that feedback applies in technological systems and systems involving animals - it also applies to the environment - a complex set of interacting systems. There are interactions between different species, for instance, predator – prey systems, but also so called mutualistic systems where two species help each other. In fact, the Earth itself comprises feedback loops. This is illustrated by the Gaia hypothesis, postulated by James Lovelock, a former Visiting Professor to Cybernetics at Reading. At its strongest, the Gaia hypothesis states that the Earth is a self regulating cybernetic system, with feedback loops aimed at controlling temperature, the amount of oxygen, salinity of the sea, etc.

This concept was at first dismissed by many biologists who believed that life adapted to its environment. To demonstrate how life and the planet could interact, Lovelock produced a simple model, Daisy world. Daisy world is a grey planet orbiting a sun which is heating up (like our own). In the soil are seeds of daisies which grow between 7 and 37 degrees, but grow best at 22degrees. Initially the planet is too cold, but once it becomes warm enough, daisies grow and keep the temperature constant for a long period at 22 degrees.

MEDICAL CYBERNETICS



Medical Cybernetics covers an emerging working program for the application of systems- and communications-theory, connectionism and decision theory on biomedical research and health related questions..Medical cybernetics investigates intercausal networks in human biology, medical decision making and information processing structures in the living organism.

The development of the ideas and methods of cybernetics in medicine is taking certain principal directions, including the creation of diagnostic systems for various classes of diseases with general-purpose and specialized computers, the development of automated electronic medical archives, the development of mathematical methods of data analysis from examination of the patient, the development of methods of mathematically modeling the activity of various functional systems on the computer, and the use of mathematical machines to evaluate the patient's condition. The history of medical cybernetics and its theoretical foundations are closely linked to those of biological cybernetics.

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The internal organization of the diagnostic system consists of the medical memory (accumulated medical experience in a given group of diseases) and the logic apparatus that makes it possible to compare the symptoms found on examination to existing medical experience and to carry out the complex statistical processing of the clinical material in any given area quickly.

Mathematical modeling of the activity of various functional systems of the organism on the computer makes it possible to reveal many important aspects of their activity. Mathematical equations clarify a number of the regular patterns of interaction of the systems under study by using corresponding parameters that characterize the function of the given systems (for example, the cardiovascular system). Solving these equations makes it possible to evaluate the rules of the system being investigated.

Mathematical machines are used for the rapid evaluation of a patient's condition, both during a major and complex operation and during the postoperative period. During operations, many specialists (physiologist, biochemist, hematologist) monitor the state of the patient's most important functions by means of various electronic instruments and equipment. The efforts of the physicians and mathematicians working in the field of medical cybernetics are aimed at creating a cybernetic system that will make it possible to evaluate, compare, and integrate the readings from numerous instruments in a matter of seconds and indicate the proper decision for taking the steps necessary to restore the patient's vital functions.

The future development of medical cybernetics will involve working out means to assist the physician significantly and increase his logical and creative possibilities.

CONCLUSION

Though its still at a developing stage ,cybernetics has proven to be more than usual technological advancement .IT has shown tremendous improvement in providing medical and we expect it to shine more in the future like curing diseases like alzimehers.

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