A Short Introduction to System Theory: Indispensable Postulate Systems and Basic Structures of the Systems in Quantum Physics, Biology and Neuroscience

H. Umit Sayin

ABSTRACT

Constructing a System Theory (ST) is a method to establish a logical, mathematical, self-consistent, self-existing, coherent model to explain the interactions of the elements, functions and development of a closed or open system. System Theory (ST) is very important to define, organize, evaluate, control, regulate the systems and form mathematical models in a set of elements of that particular system. General Systems Theory (GST) is a name which has been adopted to describe a level of theoretical model-building which lies somewhere between the highly generalized constructions of pure mathematics & logic and the specific theories of the specialized disciplines. An ST can be universal, perfect, imperfect or defective; while the defective STs cannot survive. GST is a series of related definitions, assumptions, and postulates about all levels of systems from atomic particles through atoms, molecules, crystals, viruses, cells, organs, individuals, small groups, companies, societies, planets, solar systems, and galaxies. General Behavior ST is a subcategory of such a theory, dealing with living systems, extending roughly from viruses through societies. A significant fact about living things is that they are open systems, with important inputs and outputs. Laws which apply to them differ from those applying to relatively closed systems. Ludwig von Bertalanffy, the founder of ST, described two types of systems: open systems and closed systems. The open systems are systems that allow interactions between its internal elements and the environment. An open system, like space, is defined as a "system in exchange of matter and energy with its environment, presenting import and export, building-up and breaking-down of its material components." Closed systems, on the other hand, are held to be isolated from their environment. Equilibrium thermodynamics, for example, is a field of study that applies to closed systems; so are the biological cellular structures and neuroscience systems. Brain and central nervous system (CNS) are also closed systems. Establishing, for instance, an ST on CNS, will help us to use that ST not only in neuroscience, to explain the interactions of neurons, but also it will be a good aid to make new models in many other fields such as, biology, computer science, electronics, and social sciences etc., as well.

Key Words: system theory, general system theory, neuroscience, brain, open system, closed system, scientific model, social system model


Corresponding author: H. Ümit Sayın
Address: Institute of Forensic Sciences, Istanbul University, Cerrahpaşa, İstanbul
e-mail: humitsayin@gmail.com

Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Received: 26 March 2015; Accepted: 23 November 2015
Introduction

Most of the science theories and scientific systems depend on certain axioms and postulates, which constitute the basics of scientific and logical reasoning. Without establishing some rigid and robust axioms and postulates, which are stable, logical, consistent and not interchangeable, it is nearly impossible to build up a scientific theory or a consistent system. For instance, without the main postulates and definitions of point, line, plane, cube and 3-D, parallel lines, angles, it is would not be possible to establish Euclidean plane geometry-system theory; analytical geometry; mathematics; number theory; probability theory; topology; algebra; optics; static, dynamic and kinetic physics; fluid dynamics etc. (Euclid, B.C.) (See, Figure 1, 2). Axioms and postulates are a result of numerous trial-errors and they are “the established facts” in the real world. However, the reference systems are the most important. If you take the main reference system or universal set-space as a continuous plane or a cube, then the Euclidean geometry and Euclidean postulates are correct. On earth and on small dimensions, they are correct and work perfectly well, as well as the Newtonian physics does. However, if the reference system and the “universal set” have different shapes and structures, e.g. if the universal set or space is continuously curved, then the axioms of Euclidean geometry cease to work, then one needs to establish another system & system theory (ST) and other series of postulates which will work in the new “universal set”; then you have to define a non-Euclidean geometry, whereas the shortest distance between two points is a curve, not a line (Figure 2).

Non-Euclidean geometry consists of two geometries based on axioms closely related to those specifying Euclidean geometry. As Euclidean geometry lies at the intersection of metric geometry and affine geometry, non-Euclidean geometry arises when either the metric requirement is relaxed, or the parallel postulate is set aside. In the latter case one obtains hyperbolic geometry and elliptic geometry, the traditional non-Euclidean geometries. When the metric requirement is relaxed, then there are affine planes associated with the planar algebras which give rise to kinematic geometries that have also been called non-Euclidean geometry.

Another way to describe the differences between these geometries is to consider two straight lines indefinitely extended in a two-dimensional plane that are both perpendicular to a third line: In Euclidean geometry the lines remain at a constant distance from each other even if extended to infinity, and are known as parallels. In hyperbolic geometry they “curve away” from each other, increasing in distance as one moves further from the points of intersection with the common perpendicular; these lines are often called ultra-parallels. In elliptic geometry the lines "curve toward" each other and intersect (Figure 2).

After establishment of Non-Euclidean geometry and also “Topology” using the aptitude of calculus and linear algebra, it was understood that, Euclidean geometry, that was valid only practically at short distances on the globe, would not be valid at very large distances in a universal set, such as a curved universe or sphere like the globe (earth); thus, the postulates of a system are precisely dependent on the reference system and the universal set. Euclidean geometry was consistent and working perfectly in daily life at short distances and it was a consistent, self-sufficient and self-progressive system. However,
in the space and at the quantum level, whether Euclidean geometry will work is very ambiguous. Our real reference system is shown in Figures 3, 4; actually, this is only the known and discovered part of it, we do not know many pieces of the universal puzzle, but we are sure that at both sides we come across to “emptiness”. In such a massive system from $10^{25}$ meters to $10^{-16}$ meters, we are mentioning about two sphere-like sets of which diameters have an exponential relation of $10^{31}$ meters in size; namely, from quarks and hadrons to the outer limits of empty space, the size is multiplied by: $10 \, 000 \, 000 \, 000 \, 000 \, 000 \, 000 \, 000 \, 000 \, 000 \, 000 \, 000 \, 000$.

Figure 2. In non-Euclidean Geometry the correctness of the theories depend on the universal set or the reference system.

In such a huge universal set, it is nearly impossible to determine all the parameters that rule the system and to construct a very consistent “system theory” (ST) of how the universe works in macro and micro cosmos. Quantum physics, astronomy, space physics, biology, molecular biology, chemistry may have many problems to face when dealing with a reference system, of which diameters changes from $10^{25}$ meters to $10^{-16}$ meters. The postulates are very difficult to build because they may change according to new discovered facts, elements and parameters, or they may change when novel quantal or astronomical events are encountered (such as “plasma state of matter”, which was recently discovered). Postulates and laws of quantum physics may not be relevant and valid at the level of Solar System or Milky Way Galaxy. However, in smaller systems and smaller dimensions, it is easier to establish the ST and institute the postulates of the system, because the number of elements and the parameters responsible of the event interactions may decrease. Only reliable truth in the systems is pure mathematics and mathematical pure logic, which seem to be an indispensable manifestation and replication of the innate geometry and physiology of our central nervous system (CNS) and the brain. Thus, the initial determinants of a system (IDs) are;

a- Dimensions and the space of the system. (universal set and reference)
b- Elements and the number of elements of the system. (elements of the universal set)
c- Definable events of the system. (definable mathematical functions between the elements)
d- The parameters that interact to induce the events in the system.
e- Postulates that are always correct, inner-consistent and logical-mathematical in the system. (axioms)
f- Pure mathematical models and explanations of the system and the interactions in the system. (Mathematics and Physics)
g- Borders or limits of the system.
h- Whether this system is an open or closed system (see below).

An ST can be: a) universal, b) perfect, c) imperfect, d) defective and faulty.

Euclidean geometry ST is a perfect ST when the universal set is taken as a plane and a cube, but it is an imperfect ST when the universal set is taken as a sphere or as a curve. Non-Euclidean geometry ST is a perfect ST in its constrained universal set. Once established, Unified Theory of Forces (Theory of Everything) may be accepted as a "universal ST" to explain the forces which unify the space and the quantum world by means of same axioms. Most of the scientific STs are perfect STs, because they cannot abide inconsistencies and contradictions, they do not rest on contradictory information and false logical thinking, but they hold on tautologies; also, when it is understood that there are flaws and defects in the ST; the ST is re-organized and renewed.
**Figure 3.** Outer world: Macro-Cosmos. 1 meter: we are at a forest on Earth. 100 meters (10^2 m): We are at the sky. 10000 meters (10^4 m, 10 km): We are above the clouds. 1000 km (10^6 m): We are at ionosphere. 10 000 km (10^8 m): We are out of the planet Earth. 10 million km (10^10 m): We are at the orbit of Earth around the Sun. 1 billion km (10^12 m): We are above the orbits of Mercury, Venus, Earth, Mars and Jupiter. 100 billion km (10^14 m): We are out of the solar system. 1 light year (10^16 m): We are above the solar system, and see many stars as small. 100 light years (10^18 m): We are somewhere in the Milky Way galaxy, see lots of nebulae and other galaxies. 10 000 light years (10^20 m): We are about to leave the Milky Way galaxy. 1 million light years (10^22 m): We are in total emptiness, we leave Milky Way galaxy, we are surrounded by many other galaxies, 10 million light years (10^-23 m): We come to sheer emptiness and this is the limit where our radio waves can reach, we do not know the beyond, probably dark matter and emptiness and black holes.
**Figure 4.** Inner World: Micro-Cosmos. $10^{-1}$ m: We are at the leave of a tree. $10^{-3}$ m: We are at the level of plant cells $10^{-5}$ m (10 microns): We are inside the cell $10^{-6}$ m (1 micron): We are at the nucleus of the cell. $10^{-7}$ m: We are at the chromosome level. $10^{-8}$ m (10 nanometer): We are at the DNA level. $10^{-9}$ m (1 nanometer): We are at the histones and blocking blocks of chromosomes and DNA level. $10^{-10}$ m (1 Angstrom): We are at the carbon atom level, carbon atom cloud. $10^{-11}$ m (10 picometers): We are at the electron orbiting level. $10^{-12}$ m (1 picometers): We are at the empty space of the atom, in-between electrons and the nucleus of the atom. $10^{-13}$ m (100 Femtometers): We are coming closer to the nucleus of the atom. $10^{-14}$ m (10 Femtometers): We start to see the nucleus (protons, neutrons) of the carbon atom. $10^{-15}$ (1 Femtometer): We are at the level of hadrons, quarks and other inner particles of the nucleus of the carbon atom.
For instance, astronomy is a perfect ST, while astrology is a defective and faulty ST, because astrology has defects and flaws in the elements, events, postulates, parameters, logic and the mathematics of its system, no matter how ancient it is. To give some examples of the false logic and defective axiomatic system of astrology, that has been accepted as a perfect ST for many centuries:

- Astrology accepts only 12 zodiacs as an axiomatic system. However, astronomy has established that there can be more than 12 zodiacs at a given coordinate in the space, for the planet Earth there can be 13 zodiacs. *(Defective axiom)*

- Astrology accepts that universal masses and the forces induced by those masses (celestial bodies) may have an influence on the protein structure, which constitute the personality traits, of the new-born baby according to the zodiac and constellation configuration the Earth is facing when the baby is born. *(Magical and para-logical, non-scientific reasoning)*. According to the Law of Universal Gravitation (F: Force between the masses; G: Universal Gravity Constant; m₁: Mass-1; m₂: Mass-2; r: the distance between the Mass-1 and Mass-2):

  \[ F = G \frac{m_1 m_2}{r^2} \]

- Astrology accepts that, for many centuries, the configuration of the zodiacs, galaxies, constellations and stars in the universe stayed stable; however, astronomy discovered the truth that, the universe is expanding all the time and this configuration changes continually. *(False axiom and para-logical thinking)*

- Astrology is very anthropocentric and takes the human beings, the solar system and Earth as the center of the universe. Astronomy proved that this is not the fact. *(Defective axioms and reasoning)*

- According to the current understanding of physics, forces are not transmitted directly between objects, but instead are described by intermediary entities called fields. All four of the known fundamental forces are mediated by fields, which in the Standard Model of particle physics result from exchange of gauge bosons. Specifically, the four interactions to be unified are:

  **Strong interaction:** the interaction responsible for holding quarks together to form hadrons, and holding neutrons and also protons together to form nuclei. The exchange particle that mediates this force is the gluon.

  **Electromagnetic interaction:** the familiar interaction that acts on electrically charged particles. The photon is the exchange particle for this force.

  **Weak interaction:** a short-range interaction responsible for some forms of radioactivity that acts on electrons, neutrinos, and quarks. It is governed by the W and Z bosons.

  **Gravitational interaction:** a long-range attractive interaction that acts on all particles with mass. The postulated exchange particle has been named the graviton.

Modern unified field theory attempts to bring these four interactions together into a single framework and perfect GST.

*System Theory (ST)* is very important to define, organize, evaluate, control, and regulate the systems and to form mathematical models in a set of elements of that particular system. *General Systems Theory (GST)* is a name which has been adopted to describe a level of theoretical model-building which lies somewhere between the highly generalized constructions of pure mathematics and the specific theories of the specialized disciplines. Mathematics attempts to organize general relationships into a coherent-consistent system, a system however which does not need to have any necessary connections with the "real" world around us. It studies all thinkable situations or body of empirical knowledge; actually, it has also been postulated that mathematics and logic is a "reflection" or "manifestation" of the functional structure of our nervous system and of how it works. 2 + 2 = 4; because this equation has its counterparts in the structure of the nervous system, not only because 2 apples + 2 apples add up to 4 apples in the real world, since CNS is a perfect system. If we had perceived (2 apples + 2 apples) as 3 apples or 5 apples, and our logic had decided on to be 3 apples (or 5 apples), then our CNS would be a defective and faulty system. Near to this, a defective and faulty system would not survive and become easily extinct, so no CNS would be perceiving and concurring 4 real apples as 3...
apples (or 5 apples) as a result of the 50 million years of evolution of the mammals, or 500 million years of the evolution of the vertebrates after the Cambrian Explosion. Human brain and CNS is also a reflection of the outer world and macro cosmos, while, in micro cosmos, their compositions have the similar axioms and a perfect GST which has same universal laws, some of which have not been yet discovered.

GST (General System Theory) is a series of related definitions, assumptions, and postulates about all levels of systems from atomic particles through atoms, molecules, crystals, viruses, cells, organs, individuals, small groups, companies, societies, planets, solar systems, and galaxies. General Behavior ST is a subcategory of such theory, dealing with living systems, extending roughly from viruses through societies. A significant fact about living things is that they are open systems, with important inputs and outputs. Laws which apply to them differ from those applying to relatively closed systems (Miller, 1956).

When establishing the System Theory, Ludwig von Bertalanffy described two types of systems: open systems and closed systems. The open systems are systems that allow interactions between its internal elements and the environment. An open system, like space, is defined as a "system in exchange of matter and energy with its environment, presenting import and export, building-up and breaking-down of its material components." Closed systems, on the other hand, are held to be isolated from their environment. Equilibrium thermodynamics, for example, is a field of study that applies to closed systems; so are the biological cellular biochemistry and cellular neuroscience (Bertalanffy, 1969).

"A Universal and/or Perfect General System Theory" should define the basic IDSs (initial determinants) of the system. Mechanical and Electronical Engineering use the main postulates of GST to construct universal systems by means of establishing some universal mathematical connections of the axioms to the systems (such as linear algebra) (Hintersteiner, 1998; Suh, 1990, 2001, 2005). In the below formula, established by Suh, FR is the functional requirement, DP is the design parameters;

Axiom 1: The Independence Axiom. Maintain the independence of the functional requirements (FRs).

Axiom 2: The Information Axiom. Minimize the information content of the design:

\[
\begin{bmatrix}
FR_1 \\
FR_2
\end{bmatrix} = \begin{bmatrix}
A_{11} & A_{12} \\
A_{21} & A_{22}
\end{bmatrix}
\begin{bmatrix}
DP_1 \\
DP_2
\end{bmatrix}
\]

The Determinants of a Universal or Perfect System Theory

Some Historical Examples

By means of investigating and observing already existent and self-coherent, stable perfect systems, and discovering the mathematics in it, it is possible to establish and extrapolate new and similar system theories or a "Universal System Theory" which can be valid in many other systems (such as physical, chemical, biological closed systems). For instance, computer technology used various kinds of information about the neuroscience and the interactions of neurons, to build up many new perfect computer systems.

Benoît B. Mandelbrot tried to discover the mathematics in the system of nature and biology, that is how the new "fractal geometry of nature" and "Chaos Theory" was born in 1980's (Figure 5; Mandelbrot, 1982; 2004). By means of using the fractal geometry design and mathematics of fractal geometry and the interactions of it with the nature and electromagnetic waves, it was possible to build up antennas in a very small volume by Nathan Cohen, such as the ones in cellular phones, where very powerful antennas were constructed that can attract the nature's electromagnetic waves into a very small plate (Mondal, 2010; Gianvittorio, 2002; Cohen, 1997, 1999). So, by means of unraveling the mathematics of nature, it was possible to use Mandelbrot-ST of nature in electronics and communication. Also using Mandelbrot's Set, Julia Set and Lorentz Attractor and many other complimentary system theories, Chaos Theory which finds its practical applications from biology, medicine, neuroscience and quantum physics to weather forecasting, electronical engineering, nano-technology was born (Gleick, 1987; Hall, 1991; Peak, 1994; Mandelbrot, 2004).

When dealing with GST, it is not essential to establish a Universal System Theory in the beginning; a Perfect System Theory will be good enough to establish the axioms and the structure of the SYSTEM. A Perfect ST can always evolve into a Universal ST eventually. It is very important that the new established ST should not be a
defective ST, which cannot survive. Also, an imperfect ST can evolve into a perfect ST first, then into a Universal ST. However, a defective and faulty ST can never evolve into either.

Neurons, neural networks, axons, dendrites, neurotransmitters, neurochemicals, brain and eventually Central Nervous System (CNS) constitute a perfect system and the theories of neuroscience which explain the behavior of neurons, brain, CNS, and the psyche can lead to a perfect ST of the CNS, which can guide and precede to an applicable universal ST, that can also be used in other field systems, such as computer science, social systems, biological systems, electronical & mechanical engineering, etc.

Long before the discovery of action potentials, neuronal receptors, neurotransmitters, synapses, synaptic plasticity, LTP, in 1949, Donald Hebb designed an imperfect system theory for the nervous system and the theory of cellular learning, by means of observing some simple experiments and synthesizing of what was known by then (Hebb, 1949).

Hebbian theory concerns how neurons might connect themselves to become Engrams. Engrams are means by which memory traces are stored as biophysical or biochemical changes in the brain (and other neural tissue) in response to external stimuli (Ramirez, 2013; Bruce, 2001). Engrams can also be explained as a permanent neurophysiological impression left on protoplasm as the result of a stimulus or a lasting trace left in an organism by psychological experience, or simply the recording left behind in the brain by conscious experience. They are also sometimes thought of as a neural network or fragment of memory. The existence of Engram hypothesis suggested by some scientific theories to explain the permanence of memory, how memories are stored or retrieved in the brain. Understanding and explanation of the “Memory” is very important to establish the “Consciousness Theories”.

Hebb's theories on the form and function of neurons can be understood from the following:

"The general idea is an old one that any two cells or systems of cells that are repeatedly active at the same time will tend to become 'associated', so that activity in one facilitates activity in the other." (Hebb 1949, p. 70)

"When one cell repeatedly assists in firing another, the axon of the first cell develops synaptic knobs in contact with the soma of the second cell." (Hebb 1949, p. 63)
Long after Hebb, Eric Kandel, a Nobel laureate in 2000, provided evidence for the involvement of Hebbian learning mechanisms at the synapses in the *Aplysia californica*, by defining short term electrophysiological learning and LTP (long term potentiation), that occurred by means of the activation of NMDA receptors and, Na+ & Ca2+ ion influx. (Kandel, 2012).

Hebb had described the interactions of the neurons with a mathematical formula:

\[ w_{ij} = \frac{1}{p} \sum_{k=1}^{p} x_{ik} x_{jk} \]

where \( w_{ij} \) is the weight of the connection from neuron \( j \) to neuron \( i \), \( p \) is the number of training patterns, and \( x_{ik} \) the \( k \)th input for neuron \( i \). Hebbian model is a good example of how to derive an *imperfect ST* from basic observations, then into a *perfect ST* (Hebb, 1949).

Kandel, who had studied psychoanalysis as a psychiatrist, wanted to understand how the memory worked. His mentor had once said, "If you want to understand the brain you’re going to have to take a reductionist approach, one cell at a time." So Kandel studied the neural system of the sea slug *Aplysia californica*, which has large nerve cells in which it was possible to perform electrophysiological experiments and is a member of the simplest group of animals known to be capable of learning (Dreifus, 2012). Working on LTP (long term potentiation) Kandel established the basis of neuronal learning and enhanced post synaptic potentials as a response to repetitive stimuli (e.g. tetanic 100 Hz, 100-500 microamperes electrical continuous stimulation). In 1983 Kandel investigated to identify proteins that had to be synthesized to convert short-term memories into long-lasting memories. Kandel identified CREB as being a protein involved in long-term memory storage. One result of CREB activation is an increase in the number of synaptic connections. Thus, short-term memory had been linked to functional changes in existing synapses, while long-term memory was associated with a change in the number of synaptic connections, which is called "synaptic plasticity" today.

When we evaluate our CNS, what are the main determinants of a perfect CNS-system?

- It contains some elements which process the information from the outer world in the forms of mathematical units or Engrams. (vision-seeking, sound-hearing, outer world chemical molecules-smelling, shape-temperature-vibration of outer world-touching, outer world chemical molecules of food-tasting). (D1)
- It has basic units that induce electrical, electro-chemical and electromagnetic forces and energy. (Neurons, interneurons, glial cells etc.) These are the functions of IDSs and they can be explained in mathematical functions. (D2)
- It has inner-energy forming systems for the functions (mitochondria, oxidative phosphorylation and ATP). (D3)
- It has basic units that induce capacitor effects and hence produce electro-magnetic fields and conducts this energy (excitable lipo-protein structure of membranes of the neurons). (D4)
- It has a specific energy function called as “excitation” of the basic units, which are called action potentials (AP). By means of APs energy is transferred from one neuron to another. (D5)
- It has a specific energy function called as “inhibition” of the basic units, which are called inhibitory post synaptic potentials (or currents) (IPSPs or IPSCs). By means of IPSCs the transmitted AP energy is modulated, decreased at certain degrees. (e.g. by interneurons and neurotransmitters GABA and Glycin). (D6)
It has quantal units that transfer energy from one neuron to another, or prevent or decrease the transfer of energy (neurotransmitters, neurochemicals, and hormones).

It has quantal units that transfer energy from one neuron to another in a fashion to modulate functions at different areas of the brain (e.g. dopamine and serotonin are excitatory at some receptors of the neurons, inhibitory at other receptors of the neurons). (D7)

It has an electro-chemical energy and force recognizing mechanism (e.g. different receptors of the neurons) (D8)

It has auto-control and auto-feed-back systems (auto-receptors, like alpha-2 noradrenergic receptors). (D9)

It has a recycling system (re-uptake of the quantal units, re-synthesizing of the quantal units, thus reducing the loss of energy and entropy). (D10)

It has a huge combination of circuitry system (millions of neurons and networks are connected and wired into each other forming synapses). (D11)

It has all or none binary mathematical perception and information processing system such as, the current passes (1), the current does not pass (0). (D12)

It has a self-healing and self-defense mechanism (reconstructing mechanisms, immune system). (D13)

It has information recording system (memory processing). (D14)

It has information storage system (memory forming, long term memory). (D15)

It has information retrieval system (recalling the memory packages in eitherlingual Engrams or visual Engrams as pictures, or some vivid and motion picture memories). (D16) (above 16 determinants are the examples of the known determinants)

Known other determinants of the CNS (D-K-500, 501, 502...n)

Unknown other determinants of the CNS (D-UK-900, 901, 902...n) which will be understood in the near future.

If we define the CONSCIOUSNESS Function \( f() \) as self-perceiving, self-knowing problem solving to survive, self-aware, information input learning-storing-retrieving and etc. "perfect system formation"; and the Q function \( Q(D_2) \) as: to assign a "CNS determinant" to form a self-consistent, self-existing unity in coherence, in accordance, and in cooperation with all other existing determinants with a logical, mathematical, electrophysiological and molecular mechanism \( (D_1, D_2, D_3,...D_{16},...D_{K-500} D_{K-501},...D_{-UK-900}, D_{-UK-901}, D_{-UK-902}...D_{m}) \). In D-K-500, or D-UK-900 numbers 500 and 900 are given as an arbitrary examples only), then the Consciousness Function \( f(©) \) becomes:

\[
f(©) = \sum_{k=1}^{n} q_0 \cdot q_1 \cdot q_2 \cdot q_3 \cdot q_4 \cdot q_5 \cdot q_6 \cdot q_7 \cdot q_8 \cdot q_9 \cdot q_{10} \cdot q_{11} \cdot q_{12} \cdot q_{13} \cdot q_{14} \cdot q_{15} \cdot q_{16} \cdot q_{K-500} \cdot q_{K-501} \cdot ... \cdot q_{-UK-900} \cdot q_{-UK-901} \cdot q_{-UK-902} \cdot ... q_{-UK-m} \]

Even though we do not know D-UK901....D-UKm , it is possible to form a perfect system theory for the CNS, just by means of analyzing and synthesizing the determinants \( D_1 \), \( D_2,...D_{16}...D_{K-500},...D_{K-501} \) and derive some possibilities using the basic axiomatic system and basic mathematical logic of the CNS, as Donald Hebb had done long before the discovery of action potentials, synapses, neurotransmitters, etc. and many of the above determinants; but he became to be correct in his assumptions. Asking questions, intuition and imagination can lead to the discovery of undiscovered elements or unknown determinants in a perfect system theory for a perfect closed system; because the system is perfect and to be perfect, we can derive the basic needs and basic inputs/outputs of the existing perfect system from the basic data and information of that particular closed perfect system. Establishing a system theory increases and enhances the insight and intuition of the "problem solver" or the scientist.

For instance, if we did not know the existence of neurotransmitters, but only knew about the action potentials (AP) propagating through neurons and the histological electron microscopic images of the neurons, determining the gaps and micro-meter spaces between the neurons (synapses). We would drive the notion of how bio-electric potentials would travel through the spaces of neural networks in the following possible mechanisms:

a-APs travel through the neurons by jumping from one neuron to another.

b-APs travel through the neurons by means of a kind of electromagnetic effect.

c-APs travel through the neurons by using a quantal effect which swims from one neuron gap junction or intercellular space
to the next one to affect the second following neuron.

After performing some specific experiments or even without doing those experiments, it would be easy to exclude or eliminate the first two assumptions just as a result of analyzing the main axiomatic system of the perfect ST of the perfect closed system of CNS and the basics of electrophysiology. So it is possible to establish some unknown determinants of a perfect system only by means of analyzing and synthesizing the “imperfect ST” in our hand and the main elements, determinants of this imperfect ST, to build up a “perfect ST” for that particular closed perfect system. A “Unifying Holistic Method” would be a way to determine new and unknown other aspects of the “whole iceberg” from the clues of the tip of the iceberg to discover the part under the sea (Figure 7).

**Figure 6.** Some of the basic determinants of CNS. **A)** A single neuron **B)** A single neuron’s connections with other neurons **C)** Network wiring of the neurons in the brain **D)** The interconnected neurons systems in a very small area of the brain **E)** Basic electrophysiological determinants of neurons; **AP:** Action Potential, **EPSP:** Excitatory Post Synaptic Potential, **IN:** Interneuron, **IPSP:** Inhibitory post synaptic potential **F)** Presynaptic Neuron; **TP:** Neurotransmitter transporter, **AR:** Auto-receptor, **SV:** Synaptic vesicles, **NT:** Neurotransmitter **G)** Postsynaptic Neuron; **GLU:** Glutamate receptor, **M-GLU:** Metabotropic glutamate receptor, **NMDA:** N-methyl-D-Aspartate receptor, **5-HT:** Serotonin receptor, **DA:** Dopamine receptor, **Ach:** Acetyl Choline receptor, **GABA:** Inhibitory gamma-aminobutyric acid receptor, **NE:** Norepinephrine - adrenergic alpha-1 receptor.
Figure 7. Observing and defining the main axiomatic system of triangle A, may lead to the assumptions and conclusions of the inner system of the bigger triangle B (Iceberg) as well as determining and defining the axiomatic system of triangle B (whole iceberg), because the main axioms of the whole system of the iceberg will also be reflected in the smaller holographic parts of the system (Iceberg). If the iceberg is a closed and perfect system, then the same axioms and main rules should be valid in every holographic piece of the iceberg. Triangles A and B have the properties of similarity, coherence and isomorphism.

Definition of a Perfect Closed System for CNS and the Brain

As an initial analysis of a perfect closed system (PCS), if we inquire some of the characteristics of a Self-Aware-Conscious Perfect Closed System (C-PCS), such as the brain and CNS, as we assume them to be perfect closed systems:

1. A C-PCS must exist. A C-PCS must be self-existent. (reflexive property)
2. The logical and mathematical rules that are valid in the whole of the C-PCS must be also valid in the parts and miniature pieces of the C-PCS. (holographic property)
3. In a C-PCS, the whole will have its own basic properties, characteristics, features and traits in each single part of itself. Basic main characteristics of the main whole will be reflected in the parts of that whole in a C-PCS. (association property)
4. By means of investigating the parts and pieces of that specific C-PCS, it may be possible to derive conclusions about the characteristics of the whole itself. (association property)
5. A C-PCS should not become extinct and not dissociate easily. A C-PCS should maintain its co-existence with the suitable environment. (reflexive property)
6. A C-PCS should construct its miniature, holographic and/or same size models or clones automatically; it should replicate. A C-PCS must be self-replicating (If we accept the body as an element or sub-structure of CNS, it is self-replicating all the time; although the neurons and the brain are said to be not replicating, this can be a defense mechanism to maintain the “information processing” throughout a life span; however, latest findings point out that
Sayın

Sayın HU., System theory, quantum physics and neuroscience

17. A C-PCS must be self-coherent. (tautology property)
18. A C-PCS must be self-consistent and should not bear any logical inconsistencies within. (tautology property)
19. If this C-PCS is a biological system, it should be self-conscious and self-aware. (consciousness property)
20. All the characteristics listed above and others to be added should be connected with each other with a Q function, which create and mold a cooperating-coherent unified coordination within the system (Figure-7). (coherence property)
21. Other. The properties and characteristics of a C-PCS may be increased gradually and there may not be a limit of the numbers of these characteristics.

In a continuing work for establishing a GST or ST for our CNS for defining it as a C-PCS, the basic characteristics can be increased before constructing a stable, robust, solid model. However, the important point, here, is that our brain functions, mind, consciousness can be put into a mathematical theory or a model and a logical perfect ST to analyze and to resolve in better ways in philosophical and neuroscientific aspects. This ST can be used for many other purposes in other fields too, such as in biology, computer sciences and electronics, behavioral sciences and social sciences as in the examples we have given above.

After analyzing the above characteristics of the CNS and the brain as a C-PCS, one might think and argue whether every human brain, psyche and Geist (a German term for spirit adopted by Hegel and Kant) are perfect systems or not! It should always be kept in mind that, even though, CNS and the brain of the Homo sapiens may still be imperfect systems, they may be at the stage of evolving into perfect systems.

Defective and faulty thinking; magical thinking; para-logical reasoning; depending on belief systems -while concurring solutions and results-, which may take their origins from the archaic knowledge of the subconscious and/or collective sub-un-consciousness may even serve as an important function for the survival of the organism or the species as explained in our former articles (Sayin, 2014a; 2014b).
The Conversion of CNS as a Perfect Closed System into the System of Theory of Social Structures

As mentioned in this article, a perfect ST designed and working for a closed system can also be applied to another version of a system; here, such as CNS model can be converted into the modelling of a perfectly working social system, which will be a subject of another article. For instance, using some of the axioms and determinants of CNS-perfect ST we can easily derive the basic needs and determinants of a social theory. Let us assume that we are establishing "a social association or NGO", names as X-NGO, which will have certain aims to fulfill. Instead of X-NGO you can also apply this theory to a Company (X-company). The main determinants of this social system would be as follows (Figure 9):

1- X-NGO (or X-Company) must have elements (human beings and assets). Here, the elements in a social system are the most important. If the perfection of the elements of a social system is very high, then the human error and flaws of the system will be decreased, the system will be more likely to survive and evolve. "Human Error" is the most important flaw of a social system; here we can make the resemblance of a "tower clock" which works and shows time by the resultant force and torque of hundreds of gears, if one gear is broken and/or works deficiently, then the clock shows wrong time or stops. (universal set and tautology property)

2- X-NGO (or X-Company) should be working on a consistent principal, rule and axiomatic system; or should have a constitution or a statue. (coherence and tautology property)
3- The logical and mathematical rules that are valid in the whole of the X-NGO (or X-Company) must be also valid in the parts and miniature pieces of this NGO or Company. (holographic property)

4- By means of investigating the parts and pieces of that specific NGO or Company, it may be possible to derive conclusions about the characteristics of the whole NGO or Company itself. (association property) For instance, if this social unity has some flaws in the structure of the system, then these flaws can easily be recognized and seen when looking at the actions of the NGO or Company.

5- A Company or NGO should not become extinct and not dissociate easily. The Company (or NGO) should maintain its co-existence with the suitable environment, the social system, other NGOs and Companies, within the globalized world. (reflexive property)

6- A Company or NGO must have a series of final sub-functions (such as analyzing, synthesizing, memory recording, memory keeping, retrieving the information, logical thinking, etc.; such as computerized functions and good record keeping; logical decisions; scientific methods in a Company or NGO.) (information processing property)

7- A Company or NGO must be free of defective and faulty functions (such as belief systems, para-logical thinking, magical thinking, emotional and instinctive decisions which interfere and contradict with the basic axioms of the perfect system, etc.) (tautology property). This is essential in a social system, as experienced in history; the social systems which are established and work on scientific basis can evolve and exist. That is how big corporations existed and evolved in the 20th Century in Western Capitalism.

8- X-NGO (or X-Company) must be self-consistent to fulfil its aims. (coherence property)

9- Each person in the system should be consistent with the aims of X-NGO (X-Company). Human error should be decreased to a minimum (tautology property)

10- This X-NGO (or X-Company) should have auto-control and feed-back system to check and determine whether it is working properly (auto control & feedback property)

11- In the social systems, where the elements are human beings, the most important defect may arise from the "human error"; X-NGO (X-Company) should decrease the human error into a minimum to exist and function properly and should delete the error factors to minimize a total resultant error. Many social systems, in history, such as communism, collapsed due the immense resultant driving force of human error. (tautology property)

12- This X-NGO (or X-Company) should process information properly. (information processing property)

13- This X-NGO (or X-Company) should be aware of its own elements and also other rival or hostile NGO's (or other companies). To give an example, most of the successful huge corporations in USA also work with CIA and NSA, getting feed-back and intelligence from them. (information processing or intelligence property)

14- The main aims and the ultimate goals of X-NGO (or X-Company) should be reflected to each unit and elements. (reflexive and tautology properties)

15- The X-NGO (or X-company) should evolve into a better system with a better organization and income. (evolution property)

16- The elements and the social structure of X-NGO (or X-Company) should be logical, rational and consistent to exist, precede and evolve. (tautology property)

17- An NGO (or Company) must have a recycling and economic, auto controlled system to reduce the increment of entropy or economic entropy (energy & anti-entropy property). In a social system the energy can be defined as:

   a. The Capital, Bonds and Money.
   b. Estate, Asset and Property.
c. The resultant working physical energy and mental energy of the individuals of and NGO or a Company.

18- All the characteristics listed above and others to be added should be connected with each other with a Q function, which create and mold a cooperating-coherent unified coordination within the system to drive a resultant outcome. (coherence property)

19- The properties in cooperation with an existing perfect closed system of X-NGO (or X-Company) can be increased to a certain degree, with adding some new statements and also properties.

20- Other.

The properties and characteristics of a C-PCS may be increased gradually and there may not be a limit of the numbers of these characteristics.

The Importance of Establishing System Theories

This article is only a short introduction to define the brain and CNS as a Conscious Perfect Closed System (C-PCS) and pointing out a similarity of a Closed Perfect System of CNS to social systems. Once an ST on CNS is established pondering on what we currently know about neuroscience, it may be possible to investigate the brain and the psyche, as well as the fields of neurology, psychology and psychiatry in a better scientific context. When we investigate the history of science and neuroscience, actually such a methodology has been utilized as a scientific procedure for the last decades, even though the ST of the neurological system has not been defined or established and such terms have not been articulated. Reductionist approach can be a good discipline to reveal the behaviors of the individual elements and some mechanisms of the system (e.g. neurons, receptors, neurotransmitters, excitable membranes, voltage-gated channels, pores, c-AMP mechanisms, Na⁺-K⁺ pump etc.). However, without a holistic approach and synthesizing effort to combine and coordinate this enormous amount of accumulated information and without defining universal laws and axioms, the inter-relations between them, it will be very difficult to understand how the whole system is working. For a holistic approach to evaluate the whole, we need to define and develop such systems and system theories.

Acknowledgements

This review is supported by İstanbul University funds and BAP (Bilimsel Araştırma Projeleri Birimi and Bilimsel Yayınları Destekleme Fonu).
References


Euclid (Euclides), Elements, Volumes 1-13, B.C.


