

Pioneers of Modern Electro-Stimulation Technology



The beginning of electrical stimulation for abating physical pain is lost in antiquity. Early accounts of using torpedo fish and eels to deliver strong electric shocks to the body were known to exist in the Egyptian civilization. Magnetic iron lodestones and electrically charged Amber were all known to most ancient peoples. Galen, (131-201 AD) the famous Roman physician, records the use of electrical fish to cure gout and other diseases. Electric fish were used in India and the Middle East throughout the middle ages and into the mid 19th century. The eighteenth through the early twentieth century saw the use of Leyden jars, and all types of static electricity collecting and discharging devices. Many types of direct current devices were invented and applied to various areas of the human body for a multiplicity of disease conditions.

Nicola Tesla invented the modern transformer and opened the door for the practical application alternating electricity. Electro-therapy followed suit, developing devices based upon the generation of biphasic alternating electrical wave forms. In Tesla's lifetime thousands of alternating current devices were deployed by medical practitioners of all genres and mores. Some were effective for their stated purpose, but many were conceived with hucksterism and quackery in mind. To the uneducated public the medical use of electricity was still a mysterious and magical force. Early twentieth century Hollywood depictions of Frankenstein in the Transylvanian laboratory did little to clarify the legitimate therapeutic application of electricity. The role of bio-electromagnetism, bio-electricity, and the nature of the biological photon and electron, was poorly defined and critical concepts established by

basic research into cellular and sub-cellular physiology necessary for the application of any clinically effective technology was sorely lacking. Modern tools for exploring those realms had not been invented.

During World War I electro-therapy began to be utilized to hasten recovery of peripheral nerve injuries with some success. Nothing new developed in the field then for the years between the wars. During the later stages of World War II, and soon after, emphasis on the field of physical therapy and rehabilitation slowly gained in professional stature, though reliance was placed primarily on patient initiated performance and exercise, and little on external light, sound, physical manipulation, or electrical physical therapy devices. Later diathermy and ultrasound were introduced.

Local electrical analgesia as a phenomenon then lay dormant until its republication by Wall and Sweet in 1967 under the impetus of investigations originally initiated to study the effects of 'gating' peripheral input. Melzack and Wall released their famous pain gate theory forming the conceptual basis of Transcutaneous Electrical Neuro-Stimulation. Kane and Taub reported temporarily abolishing chronic pain by electrically stimulating peripheral nerves via electrodes on the surface of the skin; the technique soon became known as 'Transcutaneous Electrical Nerve Stimulation (TENS)' (Wall and Sweet 1967).

President Richard Nixon re-established relations with mainland China in the decade of the seventies and the ancient art of acupuncture was introduced on a broad scale to the West. But in the early fifties, before the Nixon era cultural infusion, Dr. Rhinehold Voll had already developed Electro-Acupuncture according to Voll (EAV) in Germany. Dr. Voll and his colleagues were already established as vanguards for developing scientifically based electro-therapy and electro-diagnosis well before acupuncture became popularized in America.

The application of electrical micro-currents to inserted acupuncture needles was soon adopted as a standard practice by many therapists in every day practice, but the occidental mindset of western scientists was not just satisfied with observing the clinical outcomes of acupuncture therapy, but probed possible mechanisms of action, seeking to understand how acupuncture actually functioned. As East met West, new neuro-endocrinological and neuro-somatic models were developed. Some classical models were scrapped or modified to fit a still evolving scientific paradigm for comprehending cellular communications within the living body.

In order to acquire a true appreciate of modern BEST™ technology and its current application to therapy, the important contributions of several modern pioneers of the neuro-electro-physiological concepts are explained for the reader below.

Dr Reinhold Voll –EAV (Electroacupuncture According to Voll)



In the early fifties, Reinhold Voll, a German medical doctor, developed an electronic testing device for finding acupuncture points. He was successful in finding acupuncture points and demonstrating that these points, known to Chinese acupuncturists for millennia, had a different resistance (impedance) to a tiny electrical current

passed through the body, than did the adjacent tissues. Whereas acupuncture points displayed an impedance of about 50,000 ohms. Normal tissue displayed an impedance of 250,000 to 300,000 Many other researchers have also verified that electrical conductance at the acupuncture points is significantly greater than the surrounding tissue. Voll then began a lifelong search to identify correlations between disease states and changes in the electrical impedance of the various acupuncture points. He reasoned that

if he was able to identify electrical changes in certain acupuncture points associated with certain diseases, then he might be able to diagnose diseases more easily, or earlier. Earlier intervention was likely to be more effective. Voll was successful in identifying many acupuncture points related to specific conditions and published a great deal of information about using acupuncture points diagnostically.

Voll pioneered electro-dermal diagnosis. Before Voll's work, these ancient points had been used mainly for therapy. He found, for example, that patients with cancer in a specific organ had abnormal readings on the acupuncture points referred to as the respective organ points. Changes also occurred in the electrical impedance of specific acupuncture points associated with the inflamed musculoskeletal structures. Voll was very astute in observing and delineating the concept of biologically closed circuits and modulation of conductance/impedance of the circuits of his clinical interest. This opened the door for future researchers such as Nordenstrom and Becker to expand his concepts.

Voll discovered that certain acupuncture points showed abnormal readings when subjects were reacting in an inflammatory mode. A classic inflammatory condition he observed extensively was allergy. He made several serendipitous discoveries related to "allergy" testing. He noted some unusual readings on certain acupuncture points when a patient had a bottle of medicine in his pocket. He could remove the bottle and consistently get different readings when the bottle was in his pocket compared to when it was not. At first he was baffled as to how a closed bottle of medicine outside the body could affect the acupuncture readings. It was even more baffling when he discovered that the glass bottle of medicine could change the readings when it was in contact anywhere along the closed electric circuit involved with the testing procedure. Placing a bottle of medication directly

on the skin associated with an acupuncture point or meridian had a profound effect on his impedance measurements.

Voll and his colleagues then began work to identify the nature of these strange phenomena. They inserted a metal plate into the circuit and demonstrated that many substances that prelude changes in acupuncture point readings when ingested could produce the same changes when placed on the plate (even in closed glass bottles). They assumed that there must be some kind of electro-magnetic energy being emitted from the substances, and that these energy fields somehow traveled along the electric circuit to the body (perhaps like the energy waves representing a person's voice travels along the electric circuitry of a telephone line). From these findings, Voll developed an extensive system of electro-dermal diagnostic and therapeutic instrumentation that is still in use by electro-acupuncturist around the world.

Patrick David Wall and Ronald Melzack and the Pain Gate



Patrick David Wall



Ronald Melzack

Ronald Melzack, a Canadian psychologist and Patrick David Wall, a British physician, in 1962 presented the idea that the perception of physical pain is

not a direct result of activation of nociceptors, (the ending of sensory afferent nerve fibers) but instead is modulated by interaction between different neurons both pain-transmitting and non-pain-transmitting motor, proprioceptive etc. Activation of these nerves can block transmission of pain signals from afferent nerves, competitively inhibiting them from transmission.

The Gate theory of pain postulates that in each dorsal horn of the spinal cord there is a gate-like mechanism which inhibits or facilitates the flow of afferent pain impulses into the spinal cord before it evokes pain perception and response. Opening or closing of the 'gate' is dependent on the relative activity in the large diameter myelinated (A-beta) and small diameter fibres (A-d and C)'. Activity in the large diameter myelinated fibres tend to close the 'gate', and activity in the small diameter fibres tending to open it. TENS unit operation is consistent with this theory. Entry into the CNS can be viewed as a gate which is opened by afferent pain impulses and closed by TENS low intensity stimulation. (See section on mechanisms of pain)

Dr. Robert O. Becker defines the Perineural Nervous System



Dr. Becker described what he believed to be two separate nervous systems, one of which is responsible for the generation of the channels or meridians of energy flow of the vital energies. In the developing nervous system (NS) outside the central nervous system (CNS), perineural cells, cells which support the nerves in many ways, embryologically forms first. Neurons develop into tracts that grow within the pathway formed by the perineural cells. Perineural cells, consisting of Schwann cells and Glial cells, wrap themselves around the nerve axons.

Schwann cells consist of layers of "myelin", a type of lipid that acts like an insulator on an electric wire. The result of myelin is far faster nerve transmission of impulses than unmyelinated axons. The perineural cells, Glial, oligodendrocytes, and Schwann cells, facilitate a second type of signaling that is even more rapid than nerve impulse conduction. (See image below)

Neuron signaling is digital in nature, with action potentials that are propagated for "on" or non-propagation - "off". This is because nerve conduction is facilitated by sudden changes in the permeability of cell membranes, by voltage gated channels that open and close. Net charge is based upon the differences of positive and negative charges within the cell in respect to outside the cell. As the character of the charged ions change, the net charge changes. This is termed "*transmembrane ion flux*". The net charge before depolarization is restored by actively pumping the ions back out after the ionic inversion to restore the resting-state charge, before the event. Switching "on" is *depolarization* and switching back to "off" is *re-polarization*, "off" also being the normal charge of the resting state of the neuron. The event/unit time of depolarization/repolarization is called an "action potential". The generation and propagation of action potential are "all or none" events, hence communication by neurons in the nervous system is digital in nature. The action potential moves up the axon of a neuron like a tsunami wave through water.

Becker elucidated a second energetic and informational network which he termed the "*Perineural Nervous System*", consisting of connective tissue, *Schwann* cells and *Glial (astrocytes and oligodendrocytes)* surrounding axons and nerve fibers. The perineural system is analog in nature, generates slow moving bi-directional waves of direct current that flows throughout all tissues of the body, communicating integral and regulatory information on the cellular level.

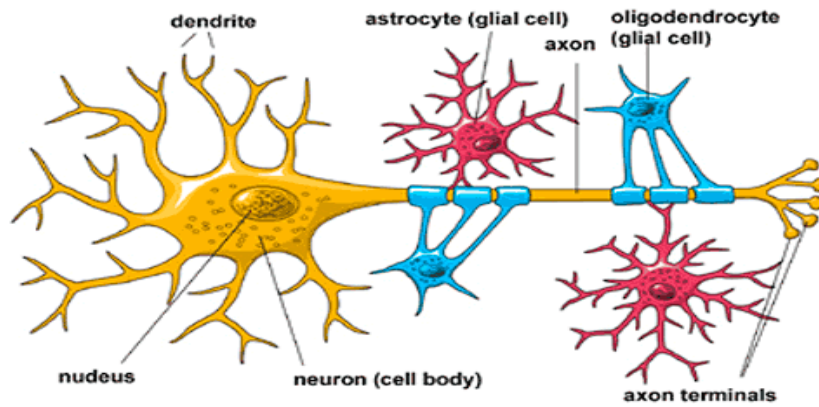


Image: [NIH](#)

Typical neuron cell body with supporting *glial* cell structures within a fiber, ganglion, or the CNS. The glial cells form the second communication system Becker termed the “*Perineural Nervous System*”.



Becker confirmed Nobel Laureate, Albert Saint Gorgyi’s hypothesis of solid state communication within the living intracellular matrix of connective substances that cements, not just the perineural nervous system cells into communication tracts, but all cells into their respective tissues.

The clinical implications of Becker’s discoveries were successfully applied for the regeneration of damaged or missing tissues/appendages, healing of wounds, and regulation of the abnormal nervous system. The Perineural System senses and communicates injury by emitting a positively charged current, which Becker termed the “current of injury”. The positively charged injury environment with respect to normal surrounding tissues creates an environment for repair and controls the healing process. Negatively charged substances such as proteins and nutrients are attracted to the area for incorporation in the healing process.

Dr. Becker found the Acupuncture Points to be stable and to produce minute (-) direct currents. The Acupuncture Points then are DC booster amplifiers

spaced along the Acupuncture Meridians. Thus, the direct currents of injury are carried to the brain, interpreted as pain and stimulate the output signals for modulating the healing process. This creates a closed-loop negative feedback system. Tissue fibroblasts secrete collagen (scarring) and sensitive cells de-differentiate and proliferate to repair the injury. A primary regulator in the healing process is the secretion of substances by the brain, spinal cord, gut, and peripheral nerve fibers, termed "neuro-peptides" (NP). Many NPs are regulatory in nature and modulate long term homeostatic mechanisms. Becker described direct nerve to epithelial cell attachments in the skin called neuro-epidermal junctions (NEJs). These junctions are crucial for any real complete healing to occur. Both these components, perineural cells and NEJs, make up the physical structures which guide the healing properties inherent in the genetic material within the nucleus of every living cell of the body. Becker believed these junctions are connected to, and are related to the acupuncture meridian system. It is these NEJs that create the minute (+) direct current of injury, at the site of trauma and thus informs the CNS where the injury is located through the perineural cells, by amplifying and boosting the signal along the meridians.

Becker's work has been foundational in the West for the field of regenerative medicine. His work served as a basis for present stem cell research and their clinical applications. In addition, his work in elucidating the nature of the perineural nervous system provided scientific evidence for the existence of acupuncture points and meridians, and explained their functioning, in the western mindset.

Erwin Neher and Bert Sakmann and the Patch Clamp

At the same time Becker began conducting his clinical research into wound healing and tissue regeneration, Erwin Neher and Bert Sakmann developed

the “patch clamp method” to prove the existence of ion channels incorporated within the outer membrane that enclose the cell. For



Erwin Neher

Bert Sakmann

their effort Neher and Sakmann were awarded the Nobel Prize in Medicine. With this method, the ionic current is measured on a tiny membrane patch to which a predetermined voltage-clamp is applied. Working within a microscopic world of minute sub-cellular structures required extreme sensitivity for measuring in angstroms, microns and pico-amperes, within micro-seconds observation intervals, and required exceptional agility for micro-manipulation of the patch. This patch is only a few square micrometers in size and contains a single ion channel. When the current is measured, abrupt, short-term jolts can be observed: The channel opens, ions flow through it, and electrical charges transfer from one side of the membrane to the other. Then the channel closes again. Currents of a few pico-Ampere can be measured within as little as one millisecond.

Neher and Sakmann succeeded in 1976 to measure the ionic current of single channels in the cell membrane of a muscle fiber. The patch clamp measurement apparatus used to provide evidence of the existence of ion channels was developed at the Max Planck Institute for Biophysical Chemistry in Göttingen and can today be viewed in the German Museum in

Bonn. This experimental set-up led to molecular electrophysiology as a recognized science.

Neher and Sakmann work has been foundational in understanding diseases termed *channelopathies*, the failure or defective function of ion channels within cell membranes. Structural proteins that comprise the walls of ion channels can be defective due to genetic damage, a heritable condition. Ion channels are also involved in myocardial arrhythmia, diabetes, high blood pressure, incontinence, multiple sclerosis, diabetes, angina pectoris and epileptic seizures. Ion channels which rely on voltage to open and close, (termed "voltage gated ion channels", VG) fail to function, simply because there is not enough potential difference in charge between outside and inside of the membrane (energy) to operate. By charging the inside of the cell membrane, which stores charge like an electronic capacitor, electro stimulation devices restore the energy necessary for voltage-gated channels to function correctly. A critical function associated VG ion channels is the regulation of blood perfusion. Neher and Sakmann's contribution to understanding cell membrane electrophysiology through the "patch clamp" has been invaluable to the fields of medicine, cell biology, pharmacology, and agriculture, and are used extensively in research laboratories throughout the world.

Contemporary Developments



Dr. Peter Fraser

Peter Fraser - Physics, Biology and the Human Body Field

In article written by physicist Peter Fraser, regarded the world expert on the human body field, Fraser expands collaborative substance to Becker's finding as to the analog nature of perineural communication and its higher level regulation of the nervous system by conceptualizing field theory.

"What is so difficult to explain about the nervous system is that it is discontinuous electrically, so clearly an electrical explanation cannot seriously be considered as an explanation. The nervous system is also discontinuous chemically, since there are synapses placed at irregular intervals in the nervous system. So, if it's not electrochemical in essence, then why is the electrochemical system even part of the nervous system's makeup? Could it be that it is there to provide the right energetic environment to make the nervous system work as a *field mechanism*? That's my thinking at this time. And what's more, it's an energy saving device so that it only works at the instant it's needed, when the nervous system needs a sudden and immediate charge, and it works in the places where it is needed by the nervous system. So for that the electrical system works, but not for an overall explanation of the nervous system.

It is interesting to note, too, that the electrical aspect of the nervous system works completely outside of the actual nervous tissue itself. This is a real

problem! The mechanism of charge and depolarization works outside of the nerve cell.”

Seven Principles of the Human Body Field

Fraser discusses the physics of resonating cavities on a macro-level arranged in the human body and micro-level as arranged in cells and tissues. He discusses communication as “pure spatial information presented in terms of structures”. Fraser defines “energetic pathology” as disease states that arise when the body is forced to use less than optimal pathways of energy and communication transmission to get its work done, pathways form organ to organ and cell to cell, nerve to nerve, even system to system. The breakdown starts in the body-field and distorts the flow of energy and communications. This is in contrast to more conventional biochemical views of pathology. This powerful article goes far in understanding the existence and function of the human body field, and further aids in the concepts of vegetative tissue dysfunctions and sub-conscious (non-nervous system) cellular communications such as acupuncture phenomenon. Without a doubt Peter Fraser understands more about the energy properties of the human field than anyone in the world today.

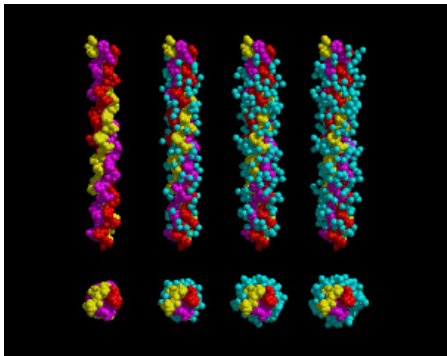


Mae Won Ho - *the Rainbow and the Worm*

Further reinforcing Fraser's concept of "pure spatial information presented in terms of structures", Dr. Mae Won Ho has written extensively on the structure of water in living systems.

In her book *The Rainbow and the Worm*, and several of her published papers, Dr. Ho explains how water bound on surfaces of proteins and membranes conducts positive electricity, and could enable cells and tissues to intercommunicate rapidly and efficiently. But for transmission of positive electricity to occur, water must be structured in a sufficiently ordered form

Hydration model of a triple helix collagen molecule over time



This serial graphic at the left is a demonstration of water hydrating Collagen over time. Positive electricity by jump proton conduction flows through collagen-bound water.

Damaged collagen retains memory of injury through the distorted crystalline structure of the water. Injured tissue inhibits proper flow.

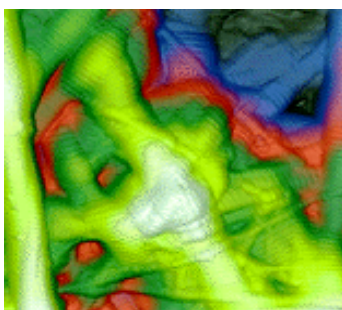
Micro-current therapy restores normal conductivity by using charge flowing through the liquid crystalline water bound to bring collagen chains back into alignment.

Diagram-Rutgers University

and have space for a proton jump to occur from one water molecule to the next. Protein and membrane surfaces in a living organism impose that kind of order on water. The spatial arrangements allow for a proton from one water molecule bound to a structural protein to jump to the next, and so

on...., allowing for the conduction of positive electricity. Jump conduction is faster than ordinary electricity passing through a metal wire, which involves electrons actually moving, and much, much faster than conduction by charged ions diffusing through water as displayed in neuronal action potentials.

Dr. Ho proposed that the acupuncture system and the DC body field of Becker (Perineural) and Fraser Human Body Field is actually a continuum of liquid crystalline collagen fibers that make up the bulk of the connective tissues (again.....Albert Saint Gorgyi cellular solid state communications idea). Bound water layers (a pure spatial informational relationship presented in structure) on the collagen fibers provide proton conduction pathways for rapid intercommunication throughout the body, enabling the organism to function as a coherent whole. Her liquid crystalline continuum mediated hyper-reactivity to allergens (a manifestation of Fraser's energetic pathology) and the body's responsiveness to different forms of subtle energy medicine. It constitutes a "body consciousness" (analog) working in tandem with the "brain consciousness" (digital) of the nervous system.



Proof of the Crystalline Structure of Collagen

Micro pictograph of actual collagen molecules under polarized light displaying the hallmark of crystalline structures known as "bi-refringence". As the plane of polarized light illuminating the microscopic dark field is shifted the molecules refract different colors. Refraction characteristics under polarized light also change with the percentage of hydration of the collagen molecule.

<http://micro.magnet.fsu.edu>

The phenomenon of bi-refringence, the changing rainbow of colored light emitted during exposure of a substance to polarized light, is the classic hall mark of crystalline structure. Collagen consists in nature of a three stranded triple helix structure. Collagen contains the amino acid "Proline". Proline is incorporated into the structural backbone of collagen- its hydrogen bonding characteristics are responsible for the helical conformation, and also for

binding large amounts of water to its exposed hydroxyl group jutting out from the surface of the molecule. In fact, collagen is saturated on its surface with water. It is this bound water that forms the liquid crystal conduction matrix. Ho refers to the bi-refringence of saturated collagen as evidence of water bound to the surface of collagen acting as a liquid crystal or semiconductor for proton conduction. It is also known that meridians conduct photons of light conduction.

Concepts of Bio-feedback: Neuroadaptation



A.N. Revenko



A. Karasev

A. Karasev, A.N. Revenko, and Ya.Z. Grinberg

While western neurophysiologists focused their attention on the classical nervous systems' producing of digital information composed of electro-chemically propagated impulses in axons and synapses, Russian doctors developed the concept of vegetative dysfunction of traumatized or pathologically affected tissues. When one tissue or organ is depleted of electrons then the metabolic function of the tissue degenerates, and the body makes adjustments by pulling energy (voltage, electrons) from other tissues in a balancing act to maintain the highest level of capacitance (i.e. maximum reduction/oxidation potential, charge) possible for energy resources available. Organs are paired so that deficient organs will borrow

energy (charge, electrons) from their partner to remedy the deficiency. This process continues until the donating organ degenerates, which in turn borrow from wherever possible. The body continues to compensate for electron deficiency and signaling patterns, exacerbating in a downward spiral to a terminal event.

Electro-stimulation devices termed *Scenar* (Self controlled energetic neuro-adaptive regulation) were developed in Russia in the mid-seventies by A. Karasev, based at Sochi University, and extensively refined by Professor A.N. Revenko (neurologist) and Ya.Z. Grinberg (electrical engineer) and many physicians and scientists based in Taganrog, Russia. They were among the first researchers to achieve repeatable therapeutic results using electrical signals to stimulate the immune system. Their devices were created for use by the Russian military and space programs with the advantages of being inexpensive, lightweight, space saving, and a practical substitute for pharmaceutical therapy. Theoretically, pharmacy supplies aboard space vessels could be reduced, saving space and weight. In 1986 their first electro-stimulation device passed technical and clinical trials and cleared by the USSR Medical Council for use in hospitals and in homes. Devices carried by the Russian Military were used to effectively treat shock and as a substitute for morphine on the battlefield. It is known that SCENAR was probably developed at a much earlier date than officially stated. Before their release to the world, the technology remained a closely guarded state secret. After the reorganization of the USSR, the technology was declassified and released to the world for humanitarian relief as a gesture of good will and a furtherance of Perestroika.

For the present conventional western mind, Fuller in 1977 defined the term "biofeedback": regardless of whether the process involves the measurement of skin resistance, temperature, brain waves, muscle tone, heart rate, etc.,

the assumption is that “biofeedback” means the use of the “conscious mind” to control “unconscious processes”. The assumed model for biofeedback was by learning although this has always been conjecture.

As biofeedback therapy developed in the West and struggled for professional acceptance among medical and mental health practitioners, a parallel Russian model for learned biofeedback behavior was developed, scientifically confirmed, and successfully implemented into their healthcare system. A second form of biofeedback that did not require the mediation of the “conscious” mind was also successfully developed. This second form of biofeedback was associated with the “conditioning” principles of behaviorism and had no requirement for “volition” or “learning”. This form of biofeedback was labeled “reflex biofeedback” in contrast to conscience “learning” biofeedback. In “reflex biofeedback”, directing micro-current stimulations of the body by way of reflexive pathways in the skin evokes informational responses to the brain. The skin and nervous system are both derived embryologically from the ectoderm layer of the developing blastocyst. Hence, the presence of Becker’s nerve to epithelial cell attachments in the skin called neuro-epidermal junctions (NEJs). The Russians developed a biofeedback device they termed SCENAR for applying to the skin. Like Voll’s impedance assessment concepts, the electrical properties of points and regions on the skin provided points of assessment for the nervous system and the internal organs that were innervated by them; the same points and regions were also used for therapeutic intervention by inputting stimulation by their device.

The cybernetic loop signaling based upon impedance as a manifestation of unconscious reflex biofeedback was utilized.

Cybernetics is defined as: *the science of communication and control processes within systems. Control is based on communication both within*

the system and with the external environment and influences the actions of the system to bring it into some desired future state or to maintain homeostasis. Cybernetics includes the concepts of auto-regulation and feedback as well as the transmission and self-correction of information, and can be applied not only to machines like computers but also to living organisms, including humans, and to complex organizations and societies.

In this case the living human organism and a “machine” (i.e. electrical impedance driven device) form an energetic and informational loop to self-correct aberrant tissue, organ, or system function.

The signaling developed, displayed a high voltage (200-300 volts) extremely short duration (micro seconds 10^{-6}) damped, sinusoidal waveform that corresponded to the digital type signaling in the small unmyelinated nerve fibers. Habituation and accommodation, a common phenomenon with nerve stimulation was avoided by the constantly changing signaling, driven by the cybernetic loop. The body, through the medium of the skin, actually directed the device as to what type of energy and information that it needed.

The analog, perineural system, body field was also affected.

Neuro-adaption is an unconscious biofeedback loop involving a specific tissue organ, or system, and the brain cortex. When an abnormal condition occurs, and could include pathology or trauma, the perineural system, or body field, senses the disturbance and sends analog signals (possibly by incoherence of water bound collagen or disturbances in conductance of meridians) to higher centers in the cortex. Concurrently, nociceptors (sensory nerve endings of c-fibers) and c-fibers may sense a direct disruption due to damage in their immediate area or sense an indirect disruption of the body field and relay digital signaling through the spinal thalamic tract to the cortex. The cortex then sets up an area to deal with the abnormality comparing the abnormality with a template of normal. The cortical center then directs the hypothalamus to reset the affected area by physiological intervention, including the release

of modulating neuro-peptides. After a restoration of normal the cortical center directing the adaptive restoration dissolves. When the neuro-adaptive loop breaks down or fails to complete a successful adaptation, the biofeedback device is inserted into the loop to provide energy and information to complete the process of adaptation and restoration.