

## **The Closed-Loop Coding-Decoding and Analysis by Synthesis as Basics Anticipatory Principle Functional Organization in the Living Systems**

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### **Abstract**

Theoretical studies of living systems (LS) from the automatic control (AC) and perceptual control systems (PCS) positions, the closed-loop coding/decoding (CL-CD) and analysis by synthesis (A-by-S) concepts, as the basic principle of the anticipatory systems (AS), reveal anticipation in functional organization of LS. The behavior of animals, especially human organisms, and of society show that model-based anticipation may be constructed cyclically, statistically as Perceptron, by the Kalman filters principles or on phenomenal memory models. It is correlated with the specific neural-structures: reptilian (as Perceptron), limbic paleo-cortex (as Kalman filter), and neo-cortex acting as neuro-quasiholographic, neuro-chaos, and factor analysis in the A-by-S decision-making system. The nontrivial Foerster-Kauffman "machine," as the CL-CD, and homunculus of vision as anticipatory perceptive A-by-S systems in the brain are proposed. Social human forecasting as the anticipation for best-organized system management is discussed.

# **The Closed-Loop Coding-Decoding and Analysis by Synthesis as Basics Anticipatory Principle Functional Organization in the Living Systems**

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**Abstract.** In conformity with the theoretical studies of the living systems (LS) from the *automatic control* (AC) and *perceptual control systems* (PCS) positions the *closed-loop coding-decoding* (CL-CD) and *analysis by synthesis* (A-by-S) concept, as the basic principle of the *anticipatory systems* (AS) functional organization was revealed. The behaviour of animals, particularly mammals, especially human organisms and society show, that model-based anticipation may be constructed cyclically, statistically as Perceptron, by the Kalman filters principles or on the phenomenal memory models. It is correlated with the specific neural-structures: reptilian (as Perceptron), limbic paleo-cortex (as Kalman filter) and neo-cortex acting as neuro-quasiholographic, neuro-chaos and factor analysis in the A-by-S decision-making system. The non-trivial Foerster-Kauffman "machine" as the CL-CD and *homunculus* of vision as anticipatory perceptive A-by-S systems in the brain are proposed. Social human forecasting as the anticipation for best organized system management and psycho-anticipatory phenomena of the mentalist Wolf Messing is discussed.

**Keywords:** anticipation, analysis by synthesis, coding-decoding, closed-loop, control, Kalman filter, limbic system, living system, cortex, phenomenal memory

## **1 Introduction**

Every living organism and their *living systems* (LS), from simple prokaryotic cells same as human and human society organizations, according J.G. Miller, are cybernetic control systems, which directly depends on the efficiency of their bio-information technologies of the controlling subsystem [1]. The theoretical studies of the LS functional organization suggest that LS are *anticipatory control systems* (ACS). Consequently, the LS and theirs biological evolution may be a good base for understanding the essence of the *anticipatory systems* (AS) functional organization and AS diversity.

The living systems are *perceptual control systems* (PCS) so its behaviour tends to be functionally purposeful and goal-directed with extrapolations, predictions, forecasting and anticipation [2, 3]. Therefore the simple or/and model based anticipations determine each PCS and living systems (LS) also.

The bio-cyber approach says that the LS are an *automatic self-control systems* because they behaviour do not understand without of the memory and predictions. Automatic control theory knows three self-control class of the cyber-systems functional organization with appropriate variations [4]:

- Feedback control without memory (FB) and with dynamic random-access memory-DRAM (FBM);
- Feed forward control without DRAM (FF) and with memory (FFM);
- Composite - feedback-feedforward without memory (FB-FF) and with DRAM (FBM-FFM) in different combinations (FB-FFM) and (FBM-FF).

The automatic control system (CS) without the use of the special memory (as FB cyclic control) device for prediction may be designated as *simple anticipatory system*. Other CS uses special anticipatory device, such as Perceptron-like or/and extrapolation and forecasting (Wiener, Zadech-Ragazzini, Gabor, Kalman) filters [4]. In addition, LS are self-production systems. According to G. Gamow and M.Yčas [5], the simple living cell is as active in plants as industrial organizations controlled by genes bioinformation technologies, as well as Maturana and Varela autopoiesic self-creation, self-production systems [6].

In 1978, Robert Rosen drew attention to the importance of anticipation for understanding life, the living and social systems. He introduced the anticipatory system concept [7, 8]. Anticipatory model-based organization in the living systems was described by Rosen at 1985-91, emphasized by D. Dubois at 1997-2011 and today by Mihai Nadin [9, 10, 11]. But anticipatory control systems organization is not yet understood and needs for additional experimental and theoretical studies.

It is clear, that the essence of anticipation (forecasting, futurecasting, extrapolation, worldwiding andclairvoing) lies in the special features of the memory mechanisms and information technology organization. The analysis of warm-blooded organisms and especially human behavior show, that model-based anticipation may be constructed on the principles phenomenal memory (FM) that is determined by the specific neural-structures (neocortex) acting as neuro-chaos and factor analysis decision-making. Upcoming theoretical model of the anticipatory system may be in the Closed-Loop Coding-Decoding (CL-CD) control system or Analysis by Synthesis (A-by-S) in the neocortex of the brain [12], [13], [14], [15], [16], [17].

Organism as every control system consists of two by special CL-CD informational procedures closely connected by techno-tools (coders and decoders) converged qualitatively different subsystems – *controlling* and *controlled subsystems* (Kirvelis, 1998-2008) [13], [14], [117]. Here controlling subsystem by signals from decoders act to controlled subsystem and determines the behaviour of it and of all organized system. This informational input generated on basis of extrapolation, prediction, forecasting, futurecasting as anticipation, *i.e.* controlling subsystem generates decision making earlier than executive organs begin to act in response to incoming commands.

The CL-CD technological convergence, together with the evolving structures of the anticipatory structures are the theoretical basis not only the

existence of all living systems, but also the of the techno-creativity. The most obvious examples of the anticipatory systems (AS) are bio-organisms, the living systems, understood by J.G. Miller's LS theory as cyber-control systems from simple cells to organisms, populations, countries, and societies [1].

Generally, the living world is a continuous bio-engineering work anticipatory creature always searching for better adaptability in a changing environment. Their behavior and their evolution, since simple convergent of Predator-Prey like systemic interaction and finishing by cybernetics of organisms, as well as science-technological development of society by creative techno-convergence developments, as the history of the anticipatory systems is. The improved structure of information control (management), the emergence of more effective memory is reflected in more expressed of the anticipatory properties of the living systems [14], [18].

One of the main steps in formation of anticipatory approach determines emergence of CL-CD, as matter-energy and information technologies convergence concept, that in essence it's extended Rosen's "Modeling Relations" approach (1985) [7], [8]. Earlier, for biological systems (cells) similar concept has been formulated by Wilhelm Johannsen as "genotype-phenotype" (1903-1911) [19], [20], [21]. The special attention deserves "Baldwin Effect" (1896), that shows the psychological learning in avifauna, mammals and humans in the anticipatory approach of Lamarck evolution, today interpreted as a manifestation of informatics anticipatory procedure [22].

Besides, the living anticipatory system has a specific evolving, yet incomprehensible phenomenal memory, who incessantly accumulate information, it sums and by special algorithms and technology make decisions on active operations. The some AS features of the possibilities may explain the BIOS: the creation organization concept (L.H. Kauffman, H. Sabelli) [23],[24].

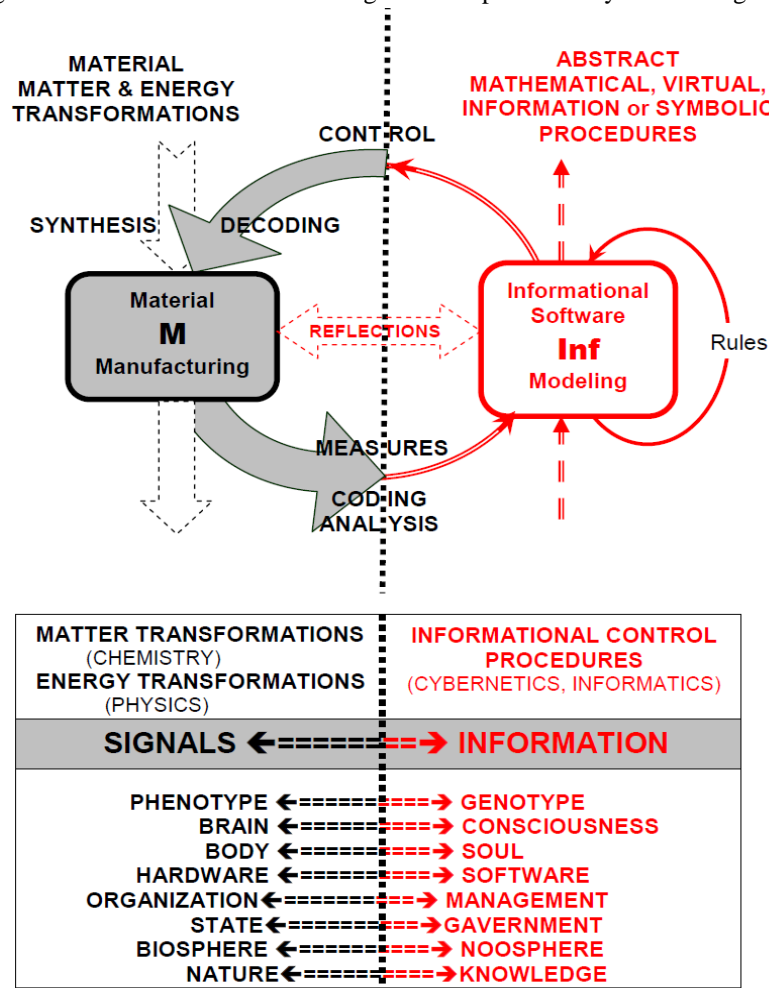
Extraordinary attention is required to the social science-technology strategy of the anticipatory (forecasting, futurcasting) U.S. and European programic approach in predicting and addressing humanity's future prosperity for the last decade: "Converging Technologies for Improving Human Performance: Nanotechnology, Biotechnology, Information Technology and Cognitive (NBIC) Science (2003-2012)" [25], „Convergence of Knowledge, Technology, and Society: beyond Convergence of Nano-Bio-Info-Cognitive Technologies CKTS-NBIC2“ (2013-2020) [25], EP STOA „Making Perfect Life, European Governance Challenges in 21st Century Bio-engineering“ (2012), [26].

Rosen's scheme of the anticipation belong to the second class of self-automatic control class, as the feedforward control system with DRAM (FFM). Most of the different levels of the living systems depends on the composite FBM-FFM class. The evolution of living systems, particularly in the evolution of vertebrate neural subsystem, demonstrate the composite FBM-FFM anticipation. Meaningfully the emergence and evolution of the anticipatory living systems interpret as starting of closed-loop coding-decoding control (CL-CDC) procedures and ending with the origin of the analysis by synthesis (A-by-S) mechanisms as perceptive, decision making methods and their significance. All

this of the living systems bio-engineered anticipatory control evolution can be explained in the CL-CDC and A-by-S) concepts [15], [17].

## 2 Closed-Loop Coding-Decoding concept

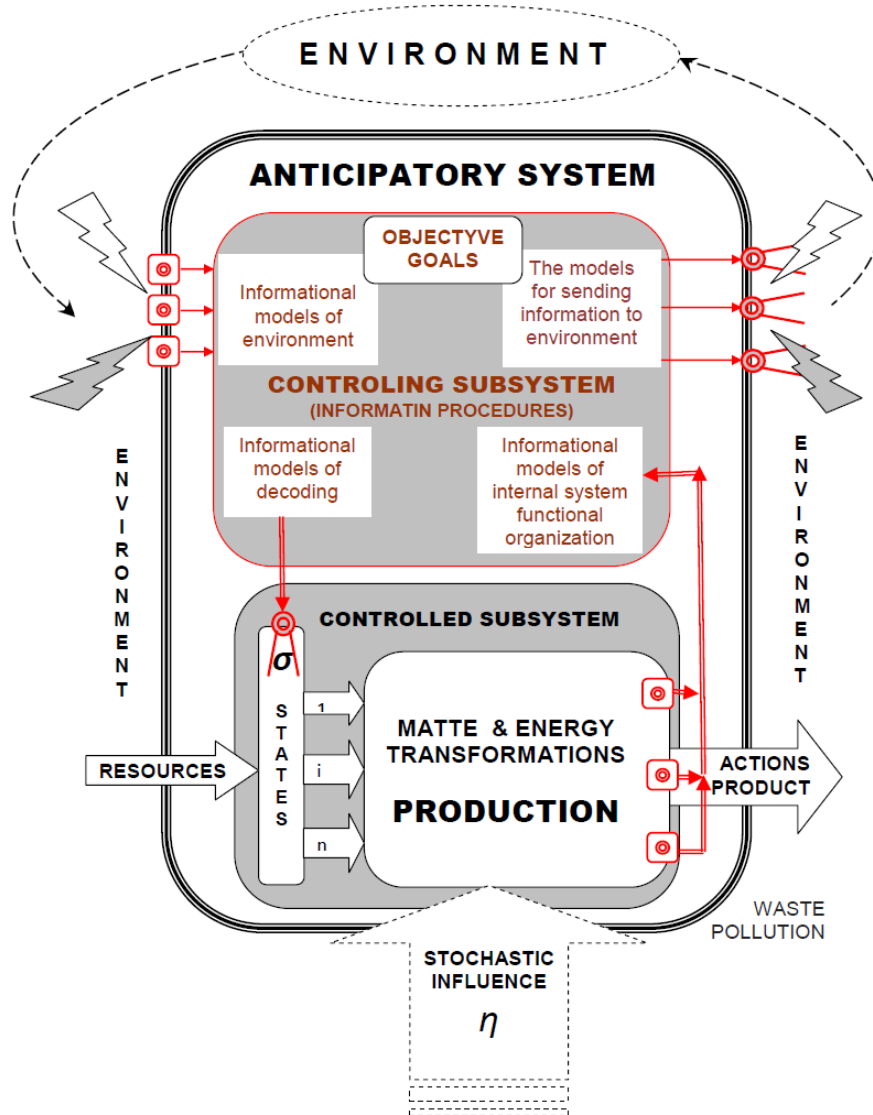
The paradigmatic essence of the functional organization presented by scheme Fig. 1.



**Fig. 1.** The paradigmatic scheme of the convergence matter-energy and information technologies or organizationally closed, matter-energy and information open by closed-loop coding-decoding (CL-CD) principle organized self-reference and techno-creativity (Extended concept of the Rosen’s Modeling Relation)

Engineered scheme of the CL-CD implementation as automatic control or anticipatory control system (ACS) functional organization presented by Fig. 2.

The closed-loop coding-decoding (CL-CD) principle are converging of two different technologies: the matter-energy transformations and the informational control processing, that originate cyclic organized the new hard-soft technology.



**Fig. 2.** Engineered scheme of the Closed-Loop Coding-Decoding (CL-CD) functional organization as the anticipatory control system (ACS)

The CL-CD request that the real matter-energy system may be reflected in the compact form of symbols on the memory and re-reflected from symbolic-

expressed memory to real matter-energy structure. That's controlled actions or production. With the special organization of the memory and learning such system are becoming anticipatory system.

Coding (encoding) should be understood as a reflection of a real system (nature or a technological process) in an abstract virtual form on memory structures (DNA, hormones, neural networks, books, programs, *etc.*) in a way that decoding from the abstract form (objective, goals, programs) to the real (material) one (and purposive actions in real system) would be possible (Fig. 1.).

This action model or a coded representation for control is the essence of information. Decoding is the realization of such a project or the control of biotechnological procedures according to information. In the process of decoding, the activated coded states of the memory structures or the projects for synthesis of reality are reflected in the dynamic states of the real world, real structures of body, *etc.* The real world is changed according to the action model.

The full CL-CD system consists of converged, partially autonomic but technologically organized systems. There are genetic, hormonal, neural, psychical, social, robotic and other organized systems in the world. Dualistic material↔informational mapping manifests itself in the following technological convergences: signal↔information; phenotype↔genotype; body↔soul; brain↔thought; hardware↔software; biosphere↔noosphere; social group↔management; state↔government, *etc.*

That systems converged according these principles are organizationally closed and informationally open. Organizational closeness causes the functional compatibility of coding-decoding and functional sense (semantics) of coded reflections. Informational openness means ability to join additional information about environment to the pool of the existing world models (the pool of gnostic and action models).

The closed-loop coding-decoding (CL-CD) principle are converging of two different technologies: the matter-energy transformations and the informational control processing, that originate cyclic organized the new hard-soft technology. The CL-CD request that the real matter-energy system may be reflected in the compact forme of symbols on the memory and re-reflected from symbolic-expressed memory to real matter-energy structure. That's controlled actions or production. With the special organization of the memory and learning such system are becoming anticipatory system.

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The presented concept of CL-CDC allows to expand and generalize the understanding of living as anticipatory systems. From the technological viewpoint, each organism needs the ability to control and coordinate the purposive transformations of matter, energy, and information using various

technological tools. These transformations have to be controlled by informational structures of controlling subsystems (controllers).

Automatic control theory knows three self-control class of the cyber-systems functional organization with appropriate variations: feedback control no memory (FB) and with DRAM memory (FBM); feedforward control no memory (FF) and with DRAM memory (FFM); composite - feedback-feedforward without memory (FB-FF) and with DRAM memory (FBM-FFM) in different combinations (FB-FFM) and (FBM-FF).

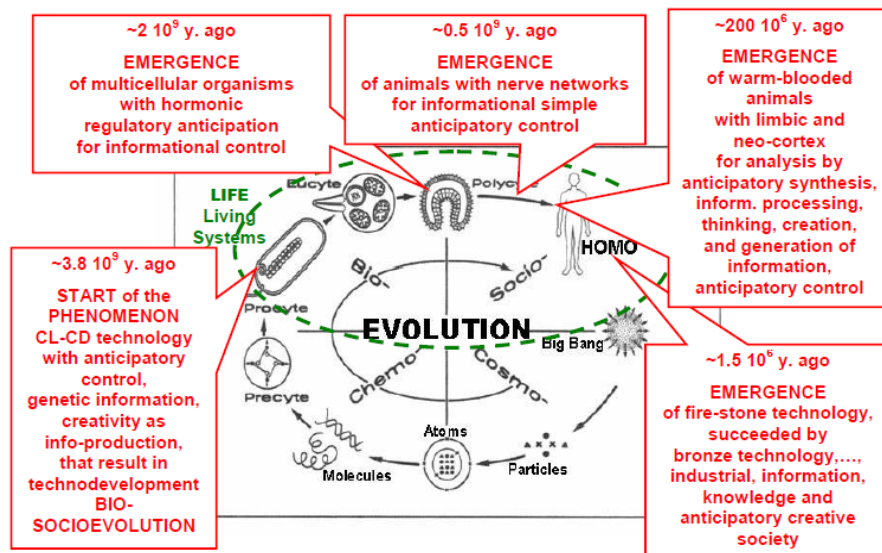
The automatic control system (ACS) without the use of the special memory device for prediction, forecasting (as FB cyclic control), some mayby named as the systems of the simple anticipatory. The cyclic control is necessary for every anticipatory control system. Model based anticipatory control systems request special memory structures. Consequently ACS systems are FBM-FFB organized structures. The engineered structure of the CL-CD functional organization as the anticipatory control system (ACS) must be able to get by coders (sensors) information about environment and form models of environment, construct models for sending information (signals) to environment, construct informational models of the internal system (by internal coders) for functional acting and decision making, create informational models of decoding for control of the resources, what is controlling ACS switch **σ**. Fig. 2. All this is implemented in a many of CL-CD loops by various technologies. General scheme shows two main CL-CD loops, inside ACS, which control inner system, and the second, which manages the system's behavior in the environment.

The variety of the ACS functional organization is best seen in review of the evolution of the LS.

### **3 The Evolution of the Living Anticipatory Systems**

The first controlling information technologies, which emerged on the Earth by way of biological evolution and still keep operating in each cell, are the genetic ones, *i. e.* bioinformational control by genes and proteins (Fig. 3, Fig. 4.). In metaphytes, intracellular genetic control is enhanced by hormonal means. On the level of metazoa, nervous networks are added. On the biosocial level, control has been extended by use of inter-individual communication agents (pheromons and acoustic signals). And on the level of a human society, the important and increasing role in control is played by information transmitted by oral and written languages, where graphical symbols are used for different modeling representations. Along with the development of human society, human reason kept creating and introducing new technologies, starting with application of fire and arriving to informational technologies.





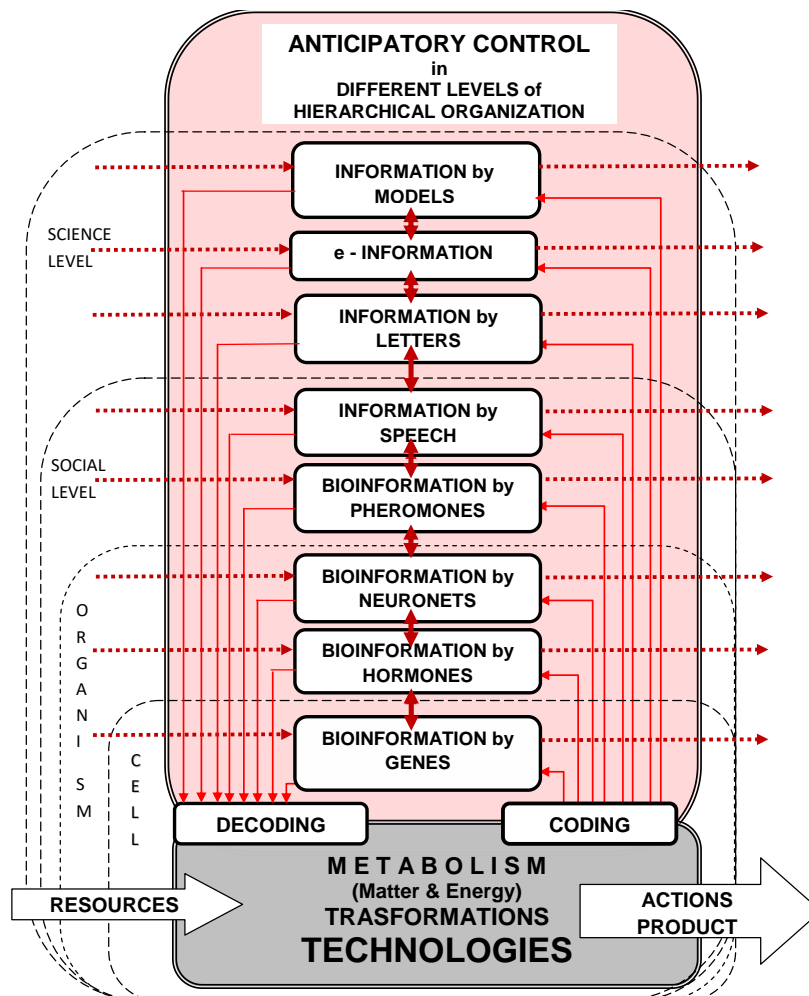
**Fig. 3.** The generalized scheme of the evolution of the living systems (LS) as an engineered symbiotic development of information technologies for anticipatory control. (On the basic W. Shwemblers scheme of general evolution)

Special interest from the technological point of view should be paid to understanding of generation of the anticipatory information. The copying (copy) of information is an informational procedure, but it creates no new information. Generation of information is important for creation of projects of new technologies. Only two bioinformational technologies in living nature produce new information (new gnostic and actional anticipatory models): 1) genetic natural biotechnology, which implements stochastic testing in living populations with the subsequent natural selection (genetic algorithms), and 2) mental natural biotechnology, which implements a motivated search, creation of virtual imitatory projects aimed at the achievement of purposes with the subsequent checks, rejection or acceptance for action.

Therefore, the substance of information theory and informatics as branches of science is the methods of quantitative estimation of information, its functional value and importance for anticipatory control and management. Undoubtedly, information and bioinformation have the common roots. They differ only in a level of world organization where they work: bioinformation in biological systems and information in social and technological systems. So, informatics should be a general science both for bioinformational and informational control-managing procedures on any organized level of organized systems.

The generalized scheme of the evolution of living systems as engineered symbiotic development of information technologies is represented in Fig. 4. The origin of life marked the start of the phenomena of technology, technological control, genotype-phenotype system on the base of genetic information. It determined bioevolution (the creation of new species) on the population level as stochastic

production of information on the principles of genetic algorithms. The origin of life is the emergence of a new sort of the organized systems. Its functioning is determined by informational control based on the principles of closed-loop coding-decoding (CL-CD). That results in the development of organism by special connections of the neural networks. The warm-blooded animals (mammals and birds) developed the neocortex of the brain, as a new neuroinformatical technology that pursues the thinking procedures.



**Fig. 4.** Different levels of closed-loop coding-decoding (CL-CD) in the different evol0utional levels or bioinformational and informational knowledge anticipatory processing in the living (biological, humanitarian and social) systems

The mental natural biotechnology is carried out by special zones of brain (neocortex) of mammals and birds. The name of such mental manufacture-generation of information is the “creative work”.

Since Aristotle, the biotheorists dealing with this problem fall into two groups: either dualistics-vitalistics or realistics-materialists. Although, it seemed that cybernetics has solved this dilemma by introducing the information and control concepts, but so far different interpretation of biosocial evolution thrives. It could be expected, that the explanation of the emergence of life and the evolution of living systems from the point of view of the organized holistic systems theory, will consolidate these different theoretical approaches. The organized systems theory explains the existence of the living systems as the complex dynamic metabolism of matter and energy. However, sustainable existence and evolution of living systems is determined by virtual information procedures, in addition to material metabolism. Therefore, the evolution of living systems should be looked at through the evolution of information technologies (Fig. 4).

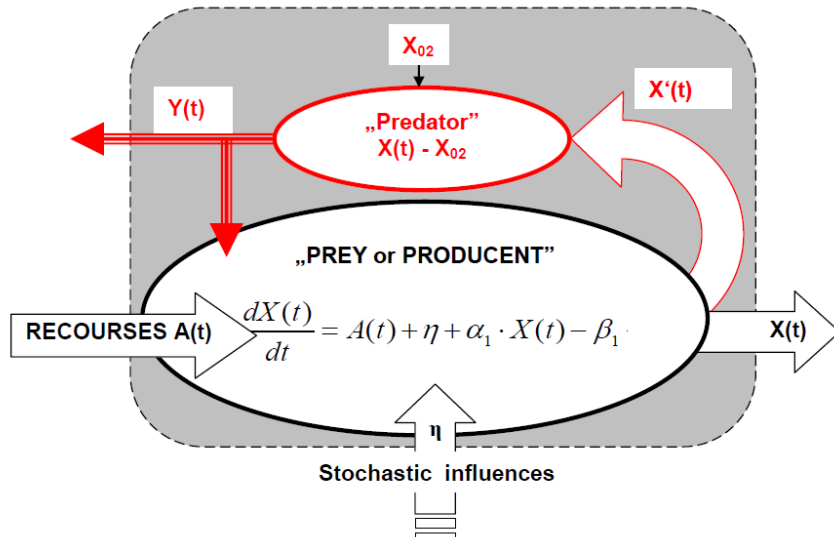
Evolutionary analysis of functional organization of nerve systems and of behavior shows five informational control levels (reflexic L.; multireflexic coordination L.; regulative L.; perceptoric analyzing L.; Analysis-by-Synthesis L.) that represent specific procedures of the closed-loop coding-decoding. Maybe weak anticipative prediction is realized at simple reflection and multireflexic coordination structures, incursive anticipative feedback control - at regulation and simple analyzers structures, and strong anticipation - at neocortex structures that work by Analysis-by-Synthesis. The strong anticipation maybe is used only in brains of mammals and birds that are able to create models of future activities that means ability to think. Higher mammals especially apes and humans have sensory screens that enhance mental imaging in *Area Striata* zone.

#### **4 Genesis CL-CD cycling, Self-reference, Self-production and Recursion as Evolution of the Predator-Prey like system**

Any ACS, especially model based anticipation systems must have cyclic dynamics, generate a variety of versions, compare version information with the existing information and change the version or to leave in the decision-making. This can be a simple continuous dynamic feedback system that meets the auto-vibrations underlying coherent requirements or discrete systems recurrence of certain procedures.

##### **4.1. Anticipatory cycling as Lotka-Volterra Predator-Prey like system**

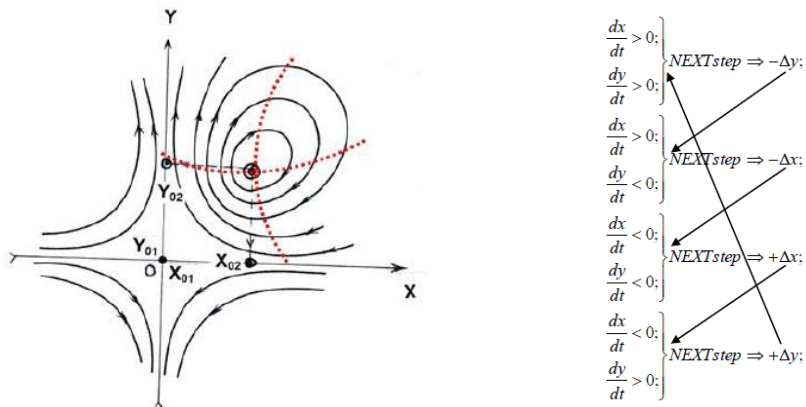
The first manifestation steps of the anticipatoric properties can be seen in constructing of the dynamic of the Predator-Prey like systems, that's reflects in oscillatoric reactions. Linear mathematical models of such dynamic systems are formulated and considered by H. Poincare, and some nonlinear - Lotka-Volterra. It is possible to see a simple anticipation in them – prediction (forecasting) of the following step.



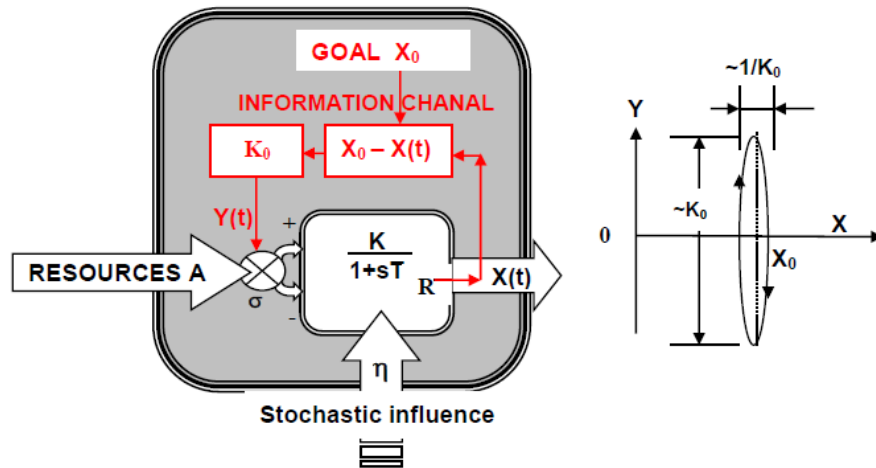
**Fig. 5.** Lotka-Volterra Predator-Prey like interaction as regulator or simple anticipatory control system

The mathematical Lotka-Volterra model consists of two "Prey" and "Predator" equations:

$$\begin{cases} \frac{dX(t)}{dt} = A + \eta + \alpha_1 \cdot X(t) - \beta_1 \cdot Y(t) \cdot X(t), \\ \frac{dY(t)}{dt} = +\beta_2 \cdot [X(t) - X_{02}] \cdot Y(t) - \alpha_2 \cdot Y(t). \end{cases}$$



**Fig. 6.** The phasic portrait of Lotka-Volterra Predator-Prey system and algorithm of cyclic dynamics as simple next-step anticipation



**Fig. 7.** Static regulator as the simple anticipatory CL-CD system with fuzzy More-Equal-Less (M-E-L) logic (+, 0, -) controller and phasic portrait of regulation

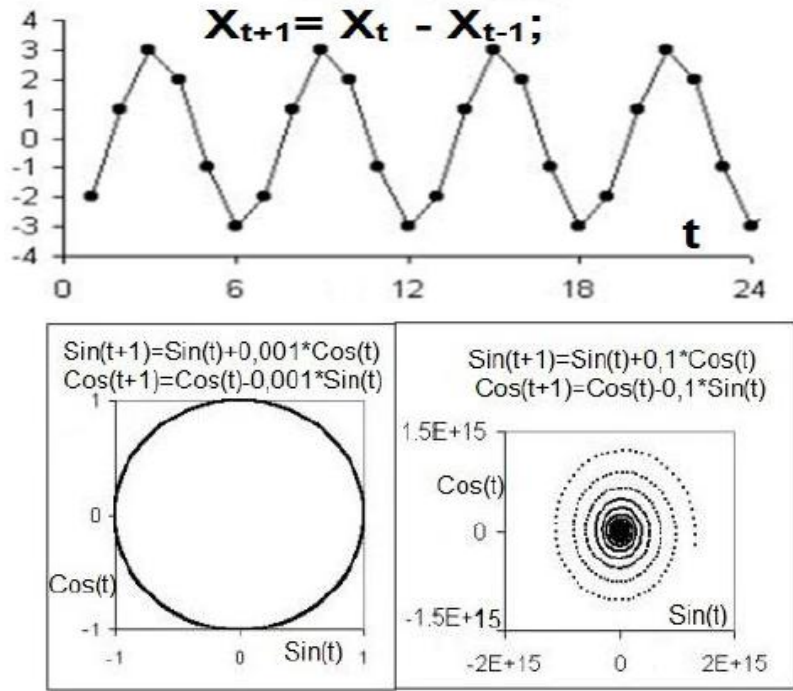
This model shows that the claims of certain auto-vibration requirements becomes a special phase portrait to a steady-state  $X_{02}$  situation in which the regulation of the process takes place (Fig. 6.).

The phase portrait shows that a dynamic system periodically predicts the next step to the new state by a special algorithm of variation (Fig. 6 right). That's may be interpreted as simple next-step anticipation

The engineered biological Lotka-Volterra model is a classic automatic controller, which by a negative feedback as informational communication, transmitting about  $\sim 1$  bit of information help maintain a stable purposeful system state (Fig. 7.). This static regulator is the simple anticipatory CL-CD control system that predict next step by fuzzy More-Equal-Less (M-E-L) or (+, 0, -) logic [14], [27].

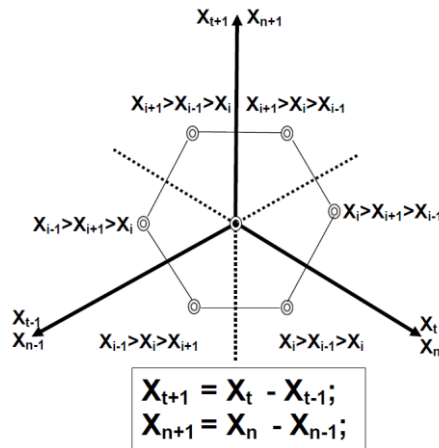
#### 4.2 Recursive processes as simple anticipatory CL-CD control

Particularly simply the auto-oscillation, the changes of system states and the characteristics of the properties explain recursive modeling that procedures are expressed in recursive equations. It clearly demonstrates the simple recursive equation  $X_{i+1} = X_i - X_{i-1}$ ; (L.H. Kauffman)., [23], [24] (Fig. 8.). These simple recursive examples allows to understand possibility of synthesize technical (electronic, molecular biology, neuron nets, etc..) of much more complex networked systems, which may be formed or shaped structure as memory models for anticipatory control. In this regard, it is worth paying special attention to the multidimensional vector recursively procedures and structures of its forming



**Fig. 8.** The simple anticipatory recursive process dynamics (L.H. Kauffman )

specificity. They can help to understand the possibilities the formation of memory models as quasineural fuzzy M-E-L logic setts (Fig. 9.).



**Fig. 9.** The vectorial recursive anticipatory process dynamics as fuzzy more-equal-less (M-E-L) logic procedures

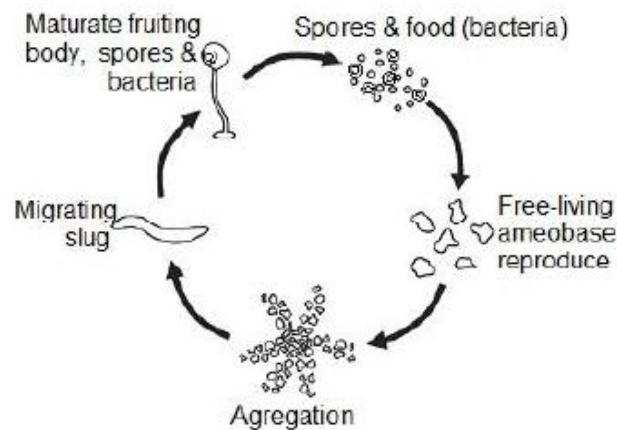
Such vector systems carry out analyze and encode of the data as a summary of the main features of the values, of the factors of importance weights for data analysis and decision-making and are sorted according to their sizes rank. The rank sequence is the main criterion for decision making.

It seems that on similar principles of cyclic dynamics are based the existence of the simple biological systems. In this regard, it is worth to showcase the social amoeba and prokaryotic cells anticipatory self-control models.

#### 4.3. The biological examples of populational and genetics anticipations

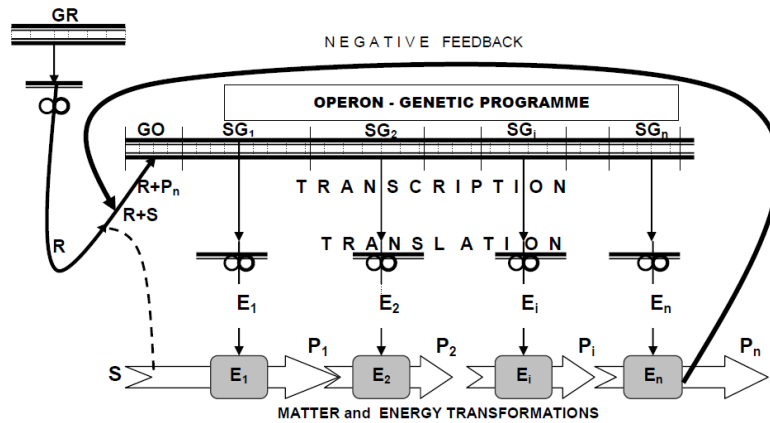
Primitive agriculture in a social amoeba as cyclic anticipatory process presented Fig. 10.

In the picture, we can see the different stages of lifecycle of the primitive social amoeba *Dictyostelium discoideum*. First, in the free-living growth stage, spores and food (bacteria) are enclosed within *D. discoideum* population. The amoebae preserve their individuality and each amoeba has its own bacterium. In the next agragation stage amoebae population forme migrating slug and migrat to otherwhere. A new, rich food place population maturate fruiting body, spores and bacteria. During the culmination stage, when the spores are produced, the bacteria pass from the cell to the sorus. Free-living amoebae seem to play a crucial role for persistence and dispersal of some pathogens in the environment. That agriculture seems to play a crucial role as anticipatory processe for pathogens survival, as they can live and replicate inside *Dyctiostelium discoideum*, making husbandry.



**Fig. 10.** Lifecycle of the primitive social amoeba *Dictyostelium discoideum* populations with genetical-bacterial anticipations

All biological processes take place in controlled cellular genetic mechanisms. One of the simplest cell is prokaryotic genetic operon system. Its functional organization presented Fig.11.



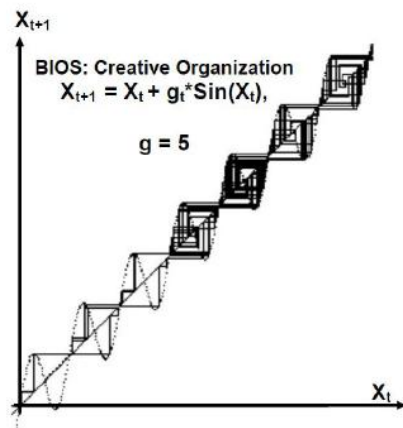
**Fig. 11.** The operon as composite - feedback-feedforward (FBM-FFM) genetic CL-CD anticipatory control in the procariotic living cells

Operon is specific biotechnological procedures system in the cell organized as a anticipatory FFM-FBM control system. It is made up of three main components: genetic memory to store information and for biotechnological this reading (transcription); translator of the information to suitable for production of materials; and third, material production by special enzymes or metabolic biotechnology procedures chain in which is the main process of the production.

But for understanding of the more sophisticated anticipatory system organization and genesis, the origin of the informational models formation structures require the emergence of new opportunities. In this case can help Bios: creative organization beyond CHAOS concept [24].

#### 4.3. BIOS: Creative Organization – anticipatory A-by-S genesis

In the Fig. 12. presented recursive process and equation (as simple mathematical models) that are representing the essence of the possible evolution of the complex systems as CHAOS, emergence of self-reference structures, L. Kauffman „maschyne“ and next biological structures.



**Fig. 12.** BIOS: creative organization beyond CHAOS as qualitative development of the anticipatory control systems (L.H. Kauffman, H. Sabelli)



Louis Kauffman's view, the BIOS: creative organization like principles enable by increasing coefficient  $g$  magnitude, starting from simple disorderly stable system initially, turns to auto-vibrating, moving to CHAOS, then form a self-referring and self-producing structures and can interpret all bio-evolution.

It is assumed that such a principle would form the structure of the CL-CD as a Kalman filter, the required learning and predictive control systems for optimal anticipatory activity.

#### 4.4. Kalman filter as anticipatory CL-CD decision making system

The Kalman filter needed for forecasting control systems. (Fig. 15.) Informational Kalman filter is hierarchical organized statistically learning structure of memory. A Kalman filter as CL-CD system is used to analyze sensor data in real time. This filter that have the statistically integrating memory structure with model-recall rate is faster then the sensor's rate. It's permit the model-based prediction, hypthesis testing and decision making [25, 26].

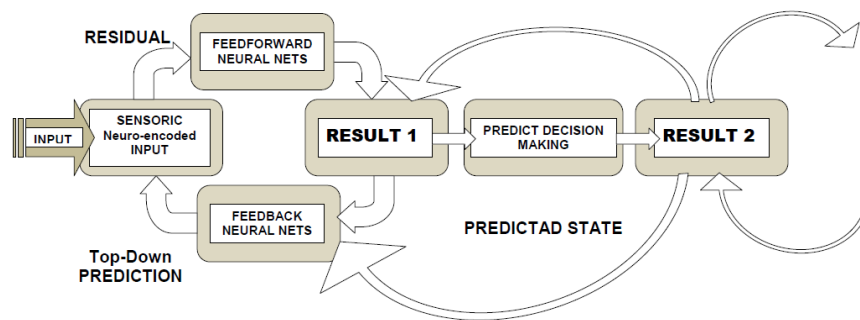


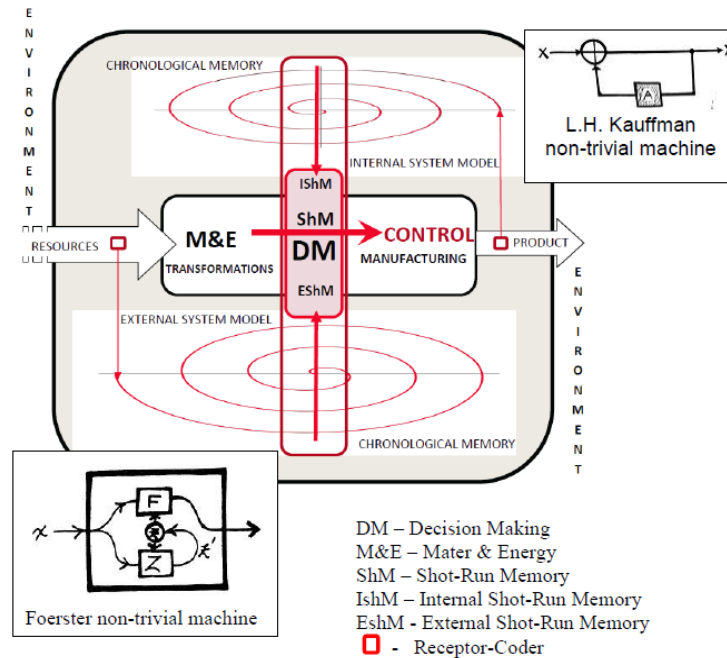
Fig.13. Kalman filter as anticipatory CL-CD control system

Kalman filter is the first step to the information CL-CD structure , which has a whole model-based anticipation. Such completed system can be anticipatory system as non-trivial Foerster-Kauffman machine.

#### 4.5. Non-trivial anticipatory CL-CD

It has long been known non-trivial Foerster machine that is a self-organizing FFM control system. L.H. Kauffman proposed other by feedback principle FBM control system also non-trivial structure model [27]. The convergence result can create a hybrid machine, which may by yet more possibilities and can match the vertebrate animal and human brain anticipatory control opportunities.

Non-trivial Foerster-Kauffman machine is whole CL-CD anticipatory system with phenomenal dynamic of memory structures (PhDAM) (Fig. 14).



**Fig. 14.** Functional organization of the evolving anticipatory Foerster-Kauffman machine

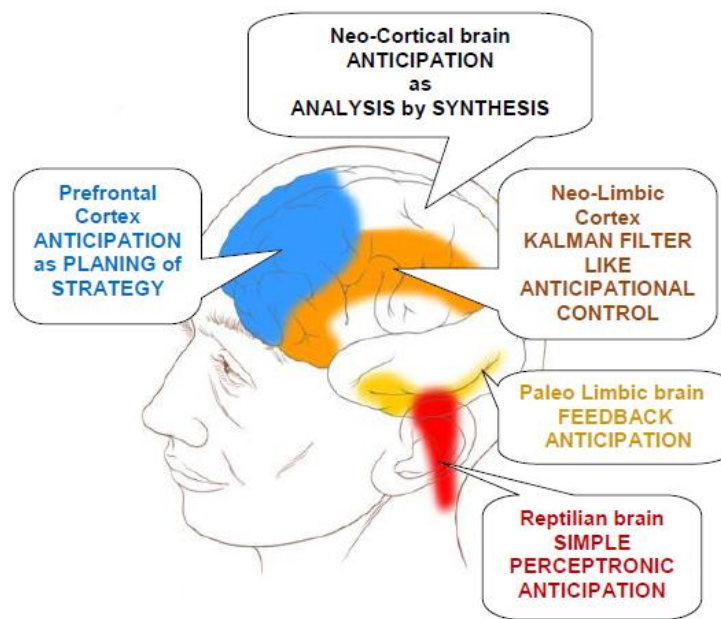
Assuming direct PhDAM FFM and feedback PhDAM FBM structures are having phenomenal qualities of the chronological memory (the memory is able to fully capture the entire life of the system epoch), then such a machine may satisfy the human brain phenomenal opportunities. These information systems must function according to the analysis by synthesis (A-by-S) principles, which plays a crucial role in the human brain simulation, comparison, decision-making and thinking processes.

## 5 The Brain as Model Based Anticipatory Hierarchic Organized Information A-by-S System

It is believed that cognitive information systems functional organization is based on analysis-by-synthesis (A-by-S) method. This method is as result of the anticipatory CL-CD control systems evolution. It is LS of the nerve subsystem and in particular the principles of brain function. They function best seen in birds, mammals, and especially in the human brain mechanisms and

behavior. Therefore, it makes sense to look at a summary of the human brain's functional organization concept.

### 5.1. General approach about human brain anticipatory action



**Fig. 15.** Perceptual anticipation in the brain (on P. J. Lynch image)  
<http://ceciled0emaiilly.files.wordpress.com/2010/09/es-anc-brain-territories.png>

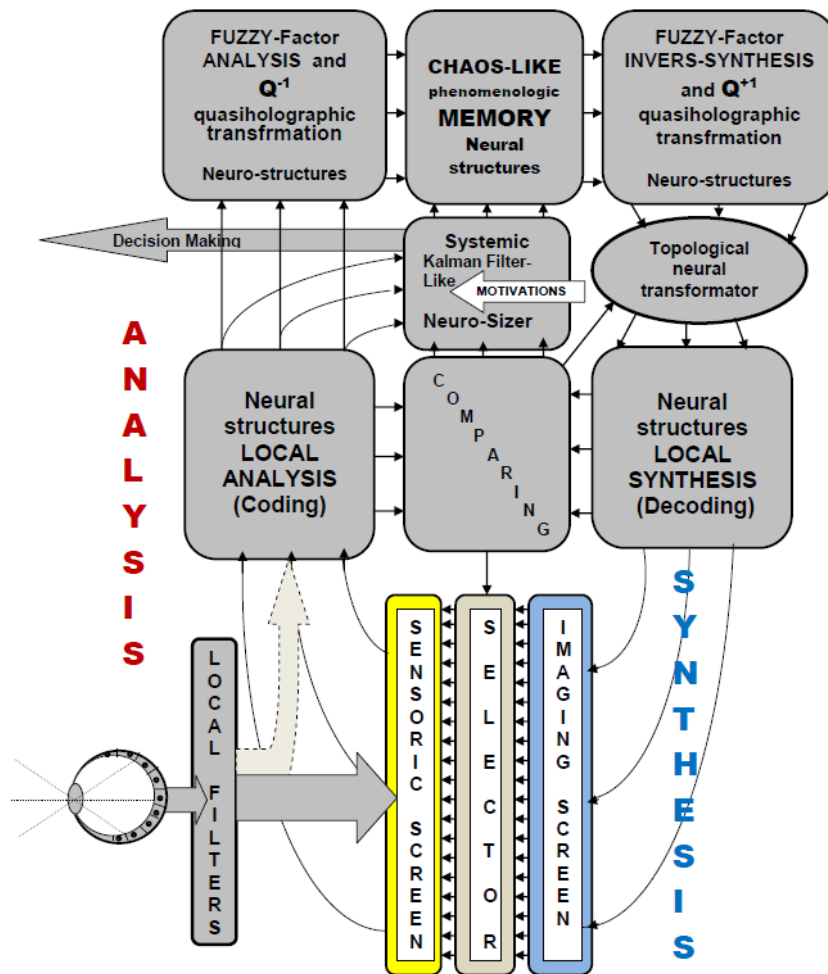
According to today's approach about functional organization of the human brain differentiates five components developed evolutionary and with the appropriate functions. The lowest level of the brain is the reptilian nervous subsystem, which is responsible for the simple Perceptronic anticipation; above is Paleo-limbic subsystem, which is characterized by the feedback anticipation; the higher level limbic subsystem carries the anticipation by Kalman filter approach; and the highest level - the structure of neocortex, acting on the A-by-S principles.

Tha's simulation hypothesis, or simulism states that's cognitive anticipatory control and thinking procedures consists of simulated interaction following four core assumptions: Internal models or simulation of actions. We can activate pre-motor areas in the frontal lobes in a way that resembles activity during a normal action but does not cause any overt movement; External models or simulation of perception. Imagining that one perceives something is essentially the same as actually perceiving it, but the perceptual activity is generated by the brain itself rather than by external stimuli; Anticipation. There are associative mechanisms of

the brain neo-cortex that enable both behavioural and perceptual activity to elicit other perceptual activity in the sensory areas of the brain.

## 5.2. The brain neo-cortex as information anticipatory A-by-S system

Overview of the neo-cortex functional organization is meaningful from positions of Perceptual activity visual analyzer. Generalized visual analyzer functional organization scheme is anticipatory A-by-S system (Fig. 16.).



**Fig. 16.** Functional organization neuro-structures of the sensory neocortex for Analysis by Synthesis (A-by-S) or imitative Closed-Loop Coding-Decoding (CL-CD), that's carry out model-based anticipatory perceptions

It is supposed that a “sensory” neuronal screen (SS) and “reconstruction” neuronal screen (RS) exist in the projection zone of visual cortex (*Area Striata* or V1). The functioning of visual analyzer consists of following intertwined operations: analysis of visual scenes projected onto SS; quasi-holographic “tracing” of images; preliminary recognition; quasi-holographic image reconstruction from memory onto RS; comparison of images projected onto SS with images reconstructed onto RS; and correction of preliminary recognition. The CL-CD procedure of analysis-by-synthesis corresponds to visual procedures on mental images. It is supposed that the image “tracing” and reverse image reconstruction based on Fuzzy-Factors analysis and special memory mechanisms and principles of brain neuronal organization as periodic CL-CD procedures.

We propose that the neuronal structure implementing the quasi-holographic Fuzzy-Factors analysis-by-synthesis ought to possess at least ten functional layered complexes: (1) the receptor layer where the retinal image is projected; (2) layer of local filtering; (3) local Hermite-Laguerre like analyzer and (4) local Hermite-Laguerre like synthesizer with (5) comparator between them. These structures are looped by quasi-holographic Fazy-Factor memory layered complexes (6, 7) with (8) special memory neural structure controlled by systemic perceptron-like classifier (9) in-between them. The memory traces are extracted by means of the topological transformations structure (10) controlled by signals from the comparator. The comparison block collates actual signal of local analysis and mental image of local synthesis.

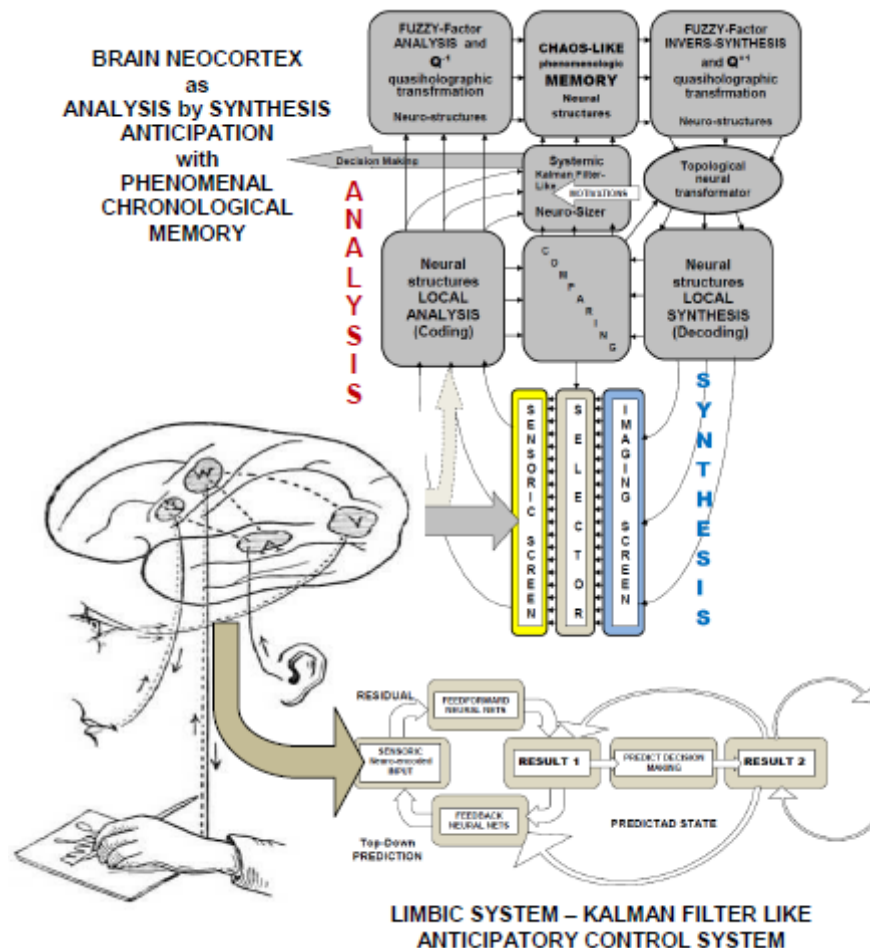
The synthesis may be accomplished by dedicated predictive structures driven by arbitrary motivations or preliminary expectations of events in environment. Note, that the system described above resembles the closed-loop coding-decoding, similar as classic non-loop communication system of the Shannon information theory, whereby analysis/decomposition and Fuzzy-Factor analysis is equivalent to the encoding step, and the reconstruction/synthesis with inverse Fuzzy-Factor analysis corresponds to decoding.

This model is based on both the visual psychophysical and neurobiological data, interpreted in the light of the theoretical solutions of image recognition and visual perception. It is believed that this model is applicable to the other neocortex perceptoric structures.

In this way it is possible to develop some of the human brain functional organization as anticipatory complex Perceptronic, Kalman filter and A-by-S structures (after Fig. 15 and Fig. 16.). It remains mysterious incomprehensible strategic of prefrontal brain anticipation and the mechanisms of phenomenal chronological memory. The brain as hierarchically organized anticipatory Perceptronic, Kalman filter, CL-CD and A-by-S informational control system Schematically presented on Fig. 17.

On the base of the similar scheme may be interrelated *Homunculus* of Vision, Auditory and others sensory functions. *Homunculus* as “internal viewer” is the complex organized neuro-informational structure of the neocortex that as analysis-by-synthesis generates infinite regress of internal viewers. Visual

sensation, for example, is activation of the two paralleled neuro-layers of the special “web round cells” neurons in the *stria Genuarri* of *Area Strcata*.



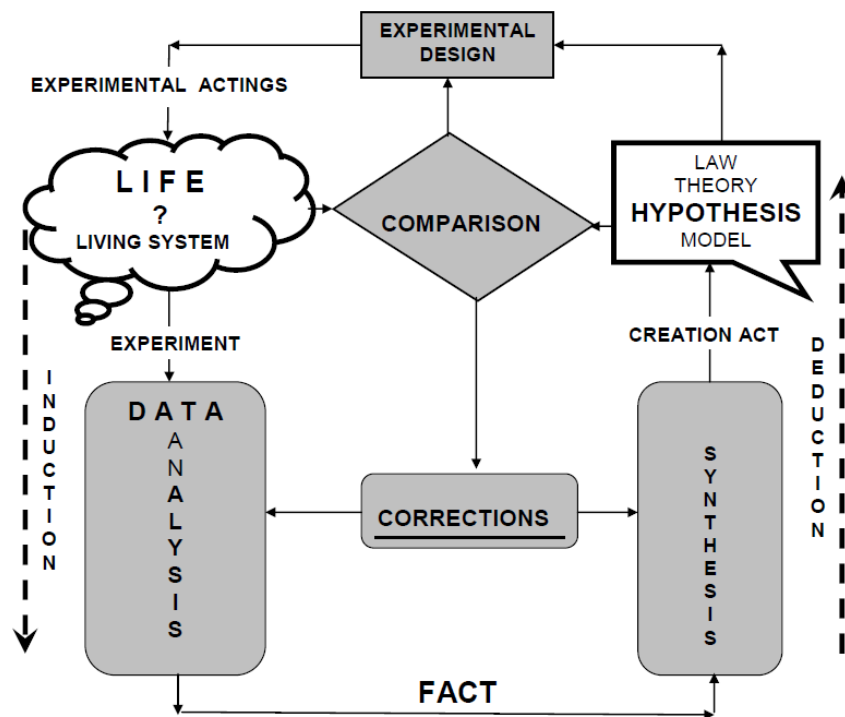
**Fig. 17.** The brain as hierarchically organized anticipatory controlling by Perceptronic, Kalman filter, CL-CD and A-by-S informational control system

The above presented scheme helps to understand the anticipation and functional mission of anticipatory structures in the general neuro-cybernetic system for the management and behavior of the organism. This scheme, functioning CL-CD and especially A-by-S methods can be used to understand the principles of human creative identity in science, technology and other issues. Accordance this principle are managed the organizations, the states, performed

forecasting of the future. Scientific neopositivistic investigation is A-by-S anticipation also.

## 6 The scientific investigation as anticipatory CL-CD or A-by-S procedure

Neopositivistic methodological scheme of the scientific investigations constructed after K.R. Popper's theory perfectly correspond to A-by-S structure and CL-CD procedures [18].



**Fig.18.** Neopositivistic anticipatory methodology of the scientific investigations (after K.R. Popper)

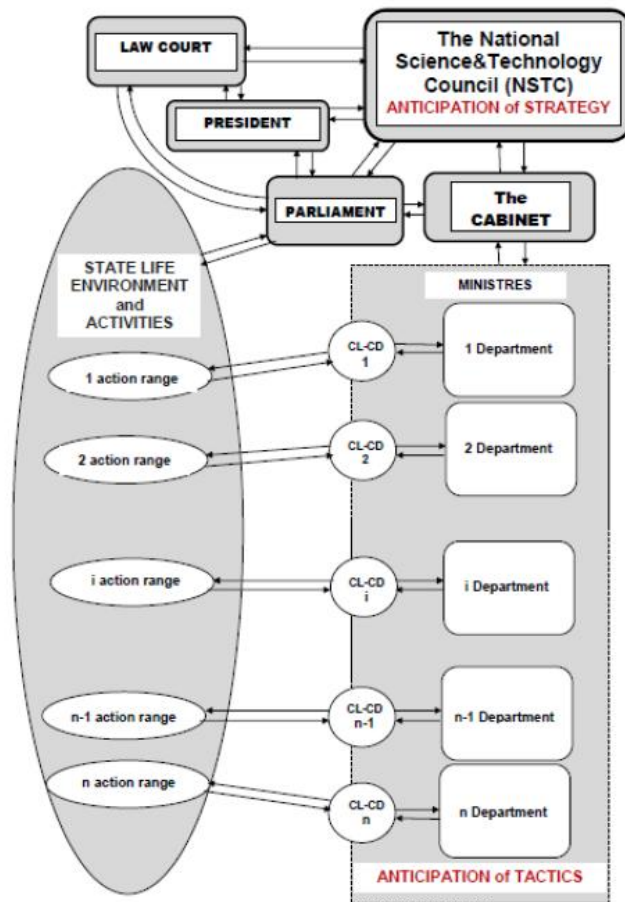
This scheme, as CL-CD structure, is constructed from: experimental scientific inductive method; the creative imagination of deductive method of formulating hypotheses and models; the comparing of the features reality with models; and further revising the formulation and execution of the experiment.

The scientific research methodology reflects the functional organization of the human brain thinking principles that's corresponds to A-by-S. By the

following A-by-S principles are advisable to manage the social systems and states.

## 7 The state governance accordingly human brain anticipatory CL-CD and A-by-S control system

Anthony Stafford Beer's *Viable System Model* of the state governance as brain-like anticipatory informational control system with strategy and tactic antisipation and Chilean Cybersyn project from 1971–1973 correspond to CL-CD and A-by-S control principles (Fig. 19.).



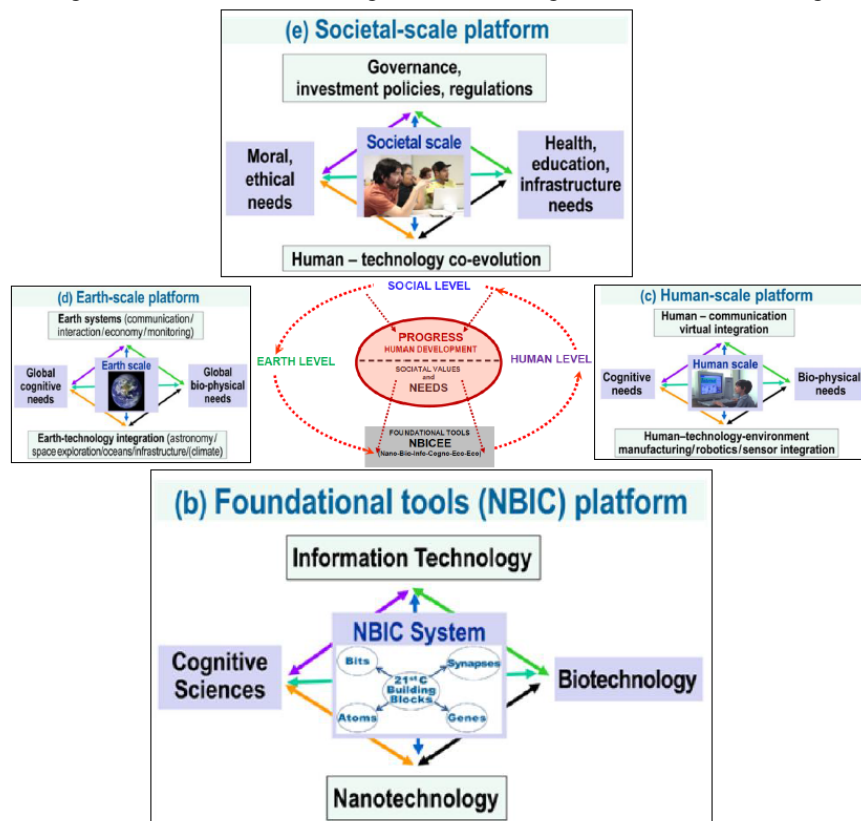
**Fig. 19.** Anthony Stafford Beer's *Viable System Model* of the state governance as brain-like anticipatory informational control system with strategy and tactic antisipation



This scheme is clearly shown the needs tactic anticipation for separate structures (departments) of implementation and for strategic "brain-like" anticipation the National Science & Technology Council necessarily. In some countries the N&S Council already exists.

## 8 The global social anticipation of the NOOSPHERE in the BIOSPHERE evolution

Today the best strategic anticipatory S&T program is U.S. NSF 2013-2020 programme "Convergence of Knowledge, Technology and Society: beyond Convergence of Nano-Bio-Info-Cognitive Technologies (CKTS-NBIC2)" Fig.20.



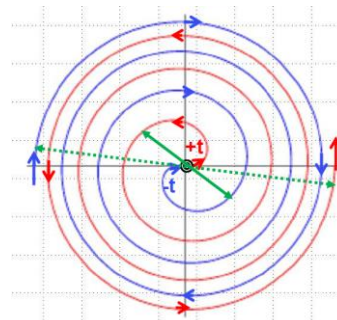
**Fig. 20.** Anticipatory USA NSF 2013-2020 programme "Convergence of Knowledge, Technology and Society: beyond Convergence of Nano-Bio-Info-Cognitive Technologies (CKTS-NBIC2)" for making perfect life in the Earth

Convergence of knowledge and technology for the benefit of society (CKTS) is the core opportunity for progress in the twenty-first century. CKTS is defined as the escalating and transformative interactions among seemingly different disciplines, technologies, communities, and domains of human activity to achieve mutual compatibility, synergism, and integration, and through this process to create added value and branch out to meet shared goals. Convergence has been progressing by stages over the past several decades, beginning with nanotechnology for the material world, followed by convergence of nanotechnology, biotechnology, information, and cognitive science (NBIC) for emerging technologies in next platforms: human, societal and Earth scales [28, 29].

## 9. Human psycho-anticipatory phenomena

Lack of understanding of science psycho-anticipatory phenomena of the *Michel de Nostredame (Nostradamus)* (1503–1566), a French apothecary and reputed seer who published collections of prophecies that have since become famous worldwide, *Baba Vanga* (1911–1996), born Vangelia Pandeva Dimitrova (Вангелия Пандева Димитрова), known after her marriage as Vangelia Gushterova (Вангелия Гущерова), a blind Bulgarian mystic, clairvoyant and particular *Wolf Messing* - (Вольф Григорьевич Мессинг) (1899 — 1974) that was an alleged psychic and telepathist mentalistic [30, 31, 32, 33]. That is the facts for science behind unexplained phenomena caused by the need to create an entirely different interpretation, the new scientific concepts of the Universe organization on the thinking base of global quantum mechanics, quantum holograms, time symetry of Universe and *etc.* Michael Talbot, was the author of several books and their relationship to ancient mysticism and the theoretical models of reality. Talbot explored the works of physicist David Bohm and neurophysiologist Karl Pribram, who independently reached the conclusion that the Universe operates on a holographic model. In Talbot's book, *The Holographic Universe*, Talbot also arrives at this conclusion and maintains that the holographic model might also explain numerous paranormal and unusual phenomena as well as offer a basis for mystical experiences of the Human psycho-anticipatory phenomena. [34, 35]

The theor-physicists Dr Julian Barbour (College Farm in the UK), Dr Tim Koslowski (University of New Brunswick in Canada) and Dr Flavio Mercati (Perimeter Institute for Theoretical Physics in Canada), have proposed a radical new theory of time for the universe, that the Big Bang create a “mirror universe” where time moves backwards, that at the time of the Big Bang not one but two universes formed – both, moving equally in each direction through time, but opposite to each other. [36]. (Fig. 21)



**Fig. 21.** “Mirror universe”

Quasi-holographic concept of the functional organization of the human neocortex (Brain) [15, 35, 37] and similar CL-CD [15], as reflections of the time-realities in the Mirror-Universe as in the Cosmic memory structure, and specific Human brain (neocortex) as quasiholographic resonators, could explain fixation our past - and our future information, and permit, by *Science-poise's* method, explain real possibilities not only *Wolf Messing's* today science behind unexplained psycho-anticipatory phenomena.

## Conclusions

The analysis of the functional organization of living systems (LS) shows that:

1. the living systems is the best examples of the anticipatory systems (AS);
2. the evolution of living systems is the most obvious history of the development of the AS;
3. the information and memory technologies are the basics components of the AS in they functional organization;
4. the AS are the convergence of the two different technologies;
5. material (matter-energy) transformation & information mutually connected (hard-soft) technology;
6. the convergence of the material (material-energy) & the information technologies implement the special encoding and decoding technology tools;
7. the higher memory capacity of the AS, the greater potential of system adaptability;
8. the Closed-Loop Coding-Decoding (CL-CD) concept is the fundamental principle of the functional organization;
9. the CL-CD concept in the AS of higher levels (aviofauna, mammals, man and society) evolve to the structures analysis by synthesis (A-by-S) of the functional organization;
10. The same CL-CD and A-by-S approach applies to the interpretation of social systems, their creation and improvement .
11. The new scientific concepts of the Universe organization on the base of global quantum mechanics, quantum holograms, time symmetry as “mirror universe” where time moves backwards, with cybernetics quasiholographic CL-CD reflecting in the Universe, permit, by *Science-poiesis* method, may explain not only *Wolf Messing's* science behind unexplained psycho-anticipatory phenomena.

## References

1. Miller J. G.: Living Systems. McGraw-Hill Book Company, New York (1978)
2. Powers W. T.: Behavior: The control of perception. Chicago: Aldine de Gruyter, Chicago (1973)
3. Powers W. T.: Living control systems. [Selected papers 1960–1988.]. Benchmark Publications, New Canaan (1989)
4. Ивахненко А.Г., Лапо В.Г.: Кибернетические предсказующие устройства. Наукова Думка, Киев (1965)
5. Gamow G., Yčas M.: The Cryptographic Approach to the Problem of Protein Synthesis. Symposium on Information Theory in Biology. Gatlinburg, Tennessee. Ed. by H. P. Yockey, Pergamon Press, New York (1956)
6. Maturana H., Varela F.: Autopoiesis and Cognition: The Realization of the Living. Boston Studies in the Philosophy of Science, Boston (1979)
7. Rosen R.: Anticipatory Systems: Philosophical, Mathematical and Methodological Foundations. Pergamon Press, New York (1985)
8. Rosen R.: Life Itself: A Comprehensive Inquiry into the Nature, Origin, and Fabrication of Life, Columbia University Press, New York (1991)
9. Dubois D. M.: Computing Anticipatory Systems with Incursion and Hyperincursion." In Dubois D M (Ed.), Computing Anticipatory Systems: CASYS'97, *AIP Proceedings* 437. pp. 3-29, New York (1998)
10. Nadin M.: Anticipation – The End Is Where We Start From. Basel: Lars Muller, Basel (2003)
11. Nadin M.: G-Complexity, Quantum Computation and Anticipatory Processes. Computer Communication & Collaboration, Vol. 2, Issue 1, pp. 16-34 (2014)
12. Кирвелис Д.: О структуре зрительного анализатора в аспекте узнавания изображений. Материалы V конференции психологов Прибалтики, с. 20-23, Тарту (1968)
13. Kirvelis D.: The Hypothesis about Basic Processes of Functional Organization Visual Analyzer (In Russian). The Modern Problems of Cybernetics, pp. 251-262, Nauka, M. (1967)
14. Kirvelis D.: The Origin of New Qualities in the Evolution of Interacting Dynamical Systems. *AIP Conference Proceedings*. American Institute of Physics, v. 465, pp.313-326, AIP, New York (1999)
15. Kirvelis D.: Visual Analyzer as Anticipatory System (Functional Organization) // *AIP Conference Proceedings*. American Institute of Physics, v. 517, p. 277-286, AIP, Melville, New York (2000)
16. Kirvelis D.: CODING-DECODING as General Anticipatory Principle of Bio-systems Functional Organization. // *International Journal of Computing Anticipatory Systems*. v.13, pp. 50-61, Liege (2002)
17. Kirvelis D., Beitas K.: Informational Closed-Loop Coding-Decoding Conception as the Base of the Living or Organized system. *AIP Conference Proceedings*. American Institute of Physics, v.1051, pp. 293-306, AIP, New York (2008)
18. Kirvelis D.: The origin of information and regulation (control) in the evolution of Predator-Prey-like systems. Proceedings of the Fourteen European Meetings on Cybernetics and Systems Research, pp. 363-367, Vienna (1998)
19. Johannsen W.L.: Arvelighedslærens elementer (The Elements of Heredity). Copenhagen, (1905)

20. Johannsen W.: Elemente der exakten Erblchkeitslehre. Gustav Fischer, Jena, (1909)
21. Johannsen W.: "The Genotype Conception of Heredity". The American Naturalist v.45 (531), pp. 129–59, University of Chicago Press (1911)
22. Kineman J.J.: Organization and Evolution: A 21st Century Baldwinian Synthesis. Proceedings of the 44th Annual Meeting of the International Society for the System Sciences, Asilomar Conference Center, p.p. Pacific Grove California, (2001)
23. Kauffman L. H.: Self-reference and recursive form. J. Social Biol. Struct. V 10, pp. 53-72, (1987)
24. Kauffman L.H., Sabelli H.: Bios: Creative Organization Beyond Chaos. University of Illinois at Chicago, Chicago,(1998) [homepages.math.uic.edu/~kauffman/BIOS.pdf](http://homepages.math.uic.edu/~kauffman/BIOS.pdf)
25. Rao R.P.N., Ballard D.H. Dynamics Model of Vision Recognition Predict Neural Response Properties in the Visual Cortex. Technical Report 96.2 National Resource Lab. For study of Brain and Behavior. University of Rochester (1995)
26. Fernando De la Torre. Component Analysis Methods for Computer Vision and Pattern Recognition. Carnegie Mellon The Robotics Institute (2011)  
[http://cvpr11.cecs.anu.edu.au/files/australia\\_summer\\_school\\_1\\_Fernando.pdf](http://cvpr11.cecs.anu.edu.au/files/australia_summer_school_1_Fernando.pdf)
27. Heinz von Foerster. How recursive is communication? (2011)  
<http://homepages.math.uic.edu/~kauffman/Luhmann.pdf>
28. Convergence of Knowledge, Technology, and Society: Beyond Convergence of Nano-Bio-Info-Cognitive Technologies, Julie 2013. Editors: M. C. Rosso, W. S. Bainbridge, B. Tonn, G. Whitesides. FinalReport/Pdf-secured/NBIC2-FinalReport-WEB.pdf  
<http://www.wtec.org/NBIC2/Docs/FinalReport/Pdf-secured/NBIC2-FinalReport-WEB.pdf>
29. Making Perfect Life - European Parliament - Europa  
[www.europarl.europa.eu/.../IPOL-JOIN\\_ET\(2012\)471574\\_EN.pdf](http://www.europarl.europa.eu/.../IPOL-JOIN_ET(2012)471574_EN.pdf)
30. Leoni Edgar. *Nostradamus and his prophecies* Dover Publications (2000)
31. Kinzer S. Rupite Journal; For a Revered Mystic, a Shrine Now of Her Own // *The New York Times*, 5 April (1995)
32. Эрлихман В. Мессинг: чародей Страны Советов // Гео, № 10 (2004)
33. Lungin T. Wolf Messing: The True Story of Russias Greatest Psychic. Glagoslav Publications. Ltd., (2014)
34. <http://www.crystalinks.com/holographic.html>
35. Talbot M. The Holographic Universe. Published by Harper Perennial/Harper Collins (1991)
36. Barbour J., Koslowski T., Mercati F.: New theory could explain our past - and our future.  
<http://www.dailymail.co.uk/sciencetech/article-2868238/Did-Big-Bang-create-mirror-universe-time-moves-BACKWARDS-New-theory-explain-past-future.html#ixzz3xVqkLt00>
37. Kirvelis. D. Quasiholographic principles of the functional organization in the the visual analyzer for images recognitions. Doctor thesis. Kaunas Medical Institute, p. 26, (1975)
38. FinalReport/Pdf-secured/NBIC2-FinalReport-WEB.pdf