# Circularity of Human Knowing and System Science

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**Abstract**

Human knowledge plays an essential role in systems complexity and its disdain reflects not only everyday life but also in hard system approaches. Its nature remains hidden and delimits a difference between knowledge as object and dynamic mental process. The biological nature of it is explained by contemporary second order cybernetic that point out two aspects of it: Knowledge is strongly coupled with individual, however it is socially constructed at the same time. Higher, more general concepts emerges in this way and constitutes culturally shared and often misjudged background of human thinking and doing. Also systemic thinking unifying modern systems science and cybernetics is such framework. The relationship of knowledge and systemic has circular character and enables to understood some problems newly, incl. some aspects of systems thinking.

*Keywords:* abstraction, concept, cybernetics, knowledge, systemic, symbol

## Introduction

Fifty years of system science and cybernetics – measured through this conference at least – is a suitable opportunity for radical reflection. There is no doubt that system thinking induces human thinking and doing in a considerable manner. Both disciplines contribute to the development of many areas of human activities namely to engineering. Perhaps more important is influence on the scientific discipline and these disciplines enrich them in (original human activities) the contrary.

Despite this we should critically face the fact that early hope and expectations were not saturated/fulfilled and advanced systems thinking is accepted just hardly and with hesitancy. Perhaps it is more obvious in post-totalitarian countries however significance of systemic ideas deserves higher appreciation all over the world. Probably the greatest disillusion dominates in managerial area in which a high expectation was connected with scientific management in sixties. This conception was based rather on systems terminology than understanding the principles as well as methodology that was focused on analysis while synthesis was derived from exact relationships of deterministic models and/or exact formulas. Many other 'schools' and 'theories' were connected with what was a nice expectation and was also connected with promises and tools that would have to warrant success from that time. Let us remember at least some of them:

- The matrix organization;

- Competitive advantage (come through IT);
- Total quality management;
- Strategic information systems;
- Business process reengineering;
- Best practices;
- ISO standards & certification;
- and others.

However some of them were based on good ideas that have fallen off in the course of time and most of them have lapsed at last. Some [Wilson, 2002] predict to the knowledge management – so popular today - the same destiny.

Nevertheless some distinctions come into the sight when we compare it with conceptions mentioned above: Primarily distinguished authors from KM domain give consideration to some theoretical issues and quest after the character of knowledge. And to explain it they deduce dramatic and seemingly paradox findings: … *knowledge cannot be managed only enabled* [Krogh, Ichijo, Nonaka, 2000]. Secondly knowledge play an essential role in complexity and to understand it gives a good opportunity to manage in conditions of increasing uncertainty. It is complexity that plays a distinctive role in contemporary systems thinking and changes our conviction concerning possibility to manage (it). While the phrase *management of complexity* was familiarly used few years ago, today is replaced by more reserved terms such as *to tackle* or *to deal with* complexity… However, what is complexity?

## Paradigmatic Movement

All human activities including scientific cognition are based on some general ideas – such as shared assumptions, theories and/or paradigms. Such and commonly shared 'framework of knowing' constitutes background for cognition that dramatically changes from time to time. This fact is consistent with Kuhn's concept of revolutionary stages of the science [Kuhn, 1970]. However it presents more general dimension and approaches to philosophy including basic conception of the word and human being. It comports with Wealtnaschauung on personal level and culture or civilization social level.

From this point of view consistently adopted systemic thinking represents similar movement of paradigm/culture as that from medieval dogmas to 'scientific' knowing. In this sense the term science corresponds to traditional Newtonian conception of empirically proved hypothesis that are epitomized to generally valid laws of deterministic character. However an advancement of such science has cast doubt on such conception during whole last century. Probably most important jumps are represented through (1) relativity theory (2) quantum physic and (3) Gödel's theorem. However cognitive principles approve to be more significant than physical or mathematical conclusion themselves: Relativity theory destroys the notion of absolute space and time, Heisenberg's and Bohr's principles refute generality and Gödel's theorem points out the imperfection of formal systems.

Shifting cognitive background have constituted environment for an advancement of knowing broadly but also in particular for the emergence of both mentioned disciplines.

The changes dramatically change basic (world) view of the universe that is fairly described by Prigogine's idea from being to becoming. [Prigogine, 1980]. Instead of static world described through sequences of determined states - new conception comes forward. Systems understood as autonomous whole emerging from the interaction of its elements and interact with other systems within environment. Such notion goes towards a dynamic nature including changes and deterministic order and substitutes them by spontaneity and chaos. Similarly cybernetics explains basic principles constituting (maintaining and changing) systems and explaining circularity subverts the reliance on linear causality…

On account of better understanding paradigmatic movement of systems thinking and also problems coupled with its consistent adoption we can introduce few cornerstones of traditional paradigm:

- Anthropic nature of the cognition resulting from generalization of individual experiences emerging through human communication and viewing the world appears from an external position and human interest.
- Objectivity and concept of the truth in the sense of two binary states (true - false, information – disinformation). Contemporary (scientific) notion oscillates between *correspondence theory* (representing objectivity) and *coherence theory* (inferring through rules). Common business covers also next two theories – consensus (normative nature) and pragmatic (derived from success).
- Determinism connecting the conception of the evolution as linear sequence of discrete states that are determined by universally valid laws (or given rules, norms and/or standards). Formal language and models based on calculus play an important role in these cases.
- Rationalism connecting reliance on human reason and it support through formalized methods (such as arithmetic and/or formal logic) to maximize utility. This aspect leads to anthropic character of progress in the sense of heading towards increasing welfare.
- Dualism that differs material and abstract systems incl. ambiguous category of mind out of brain (when information is similarly understood without its physical context).

They influence familiar world-view of wide publicity incl. great part of scholarly community and conduce to misty conception of such essential concepts as an evolution in Darwinian sense (of slow and fluent adaptation).

## Contextual origin of the disciplines

However talking about such changes we get into contemporary or advanced stage of closely coupled disciplines, we realize there are two generations:

Early stages of systems science connects with *hard approaches* (hard thinking) that is tied up with deterministic behavior and idea of (automatic) control of (instructed) systems. The situation is flagrant from the concept of black box and feedback control that are demonstrated in Figure 1.

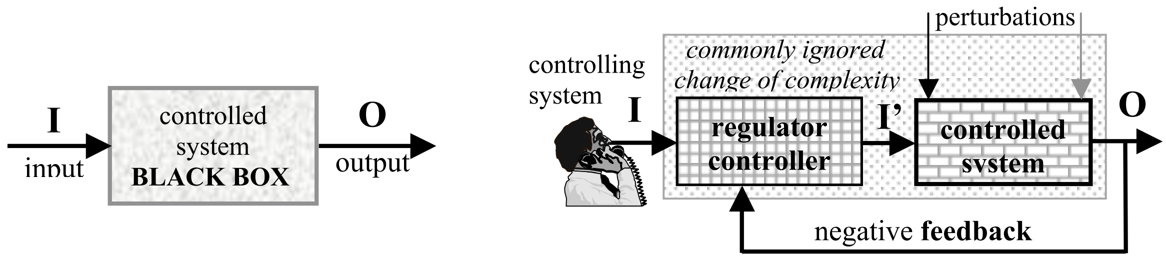


Figure 1 Idea of black box ignoring complexity and control maintain system in stable state

Idea of black box ignores (abstracts from?) the nature of considered (observed, controlled) systems and their inner complexity. It reduces situation to causal actuating of input that determine output. Also great theory feedback was based on similar view of stable states and invariant controlled system. Situation typically called control has played focal role in first theory of cybernetics [Wiener, 1948] dissembles the fact if increasing complexity of resulting from new element which is controller. Use of negative feedback consists in evaluation of desired and actual states and causal change of actual input (I') affecting controlled (stable) system. The nature of control is based on possibility to sustain given (required) state despite some perturbations coming from the environment. The role of controlling systems was ignored originally together with its intention (restricted to general purpose) and/or its knowledge (restricted to '*hash function*'). Such conception is very successful in the case when complexity of controlled system has a character of '*organized simplicity*' [Weaver, 1948] based on known and deterministic properties of its elements and their interaction. Let us point on some cited assumptions that are transferred into the concept of management:

- Foggy intention and knowledge of controlling systems (managers) and idea of stability;
- Ignored complexity of controlled systems or its substitution replacing by *combinatorial complexity* or problems to understand large (however deterministic) system;
- Exclusion of the environment that is restricted to few perturbations that can be eliminated.

Success of hard approaches lies in the advance of systems engineering as a domain of human activities oriented to the design of artifacts. To understand character of designed or artificial systems we can remember some principles of engineering that can outline the constraint of them:

- The system is arranged systematically and prevailing hierarchically aligned system structure is based on the fixed dependence of components with known and constant attributes and functions. Running processes have determined character and they are asynchronous; optional parallel processes are effectively synchronized. The uncertainty and indeterminateness of relations or properties of system components are ineligible or even inadmissible events that are necessary to be eliminated.
- System's arrangement, organization and/or order are derived from the knowledge of system's designers – such knowledge and order are inserted into (embedded)

designed system. Traditional engineering methods (applied in technical domains) are derived from the legality of physical laws and have a character of fixed rules.

- The human – in the case that he is anywise taken into account - stays outside of designed system and just the function of the 'user' or 'service' is trusted with him. The attention is focused in human-system interface and its ergonomic parameters and facility of a command.

Let us emphasize the issue of knowledge in this context: Embedded knowledge of designers and its credibility is derived from physical laws on the one side and generalized notion of user ignoring individuality of people and their distinct knowledge on the other side.

## Failure of Hard and Emergence of Soft Approaches

Identified inability of to manage (control) organization having character of social systems, have called *soft approaches* later. This conception has naturally two quite different streams:

The first faces up to determinism and considers such affairs as stochastic feature, probability and/or fuzzy sets as well as an appropriate (mathematical) tools – statistic, fuzzy logic etc. Even when these approaches have important success namely within the domain artificial intelligence, they fall short of real complexity. Ashby has appositely discerned three types of systems – (1) deterministic, (2) stochastically determined and (3) complex systems [Ashby, 1956] (Ashby has restricted his interest to the second type e.g. stochastically determined systems a due to this he was able to define complex systems**. ).** Also heuristic approaches (algorithms) that come up with a sufficient/goodish results and cut demand on solution or enable it at least (NP problems) are based on similar simplification of complexity.

The second approach is coupled with Checkland's *soft systems methodology* [1981] that respects complexity, resulting from different view of system and or problem circumscribed through more *root definitions*. Such points of view and different definitions result from different knowledge, intention and also role of involved individuals. Despite that Checkland himself emphasizes that he evolved methodology not theory his approach covers few essential principles:

1) Real diversity of people and understanding to problem (system) mentioned above
2) Difference between reality and (systems) thinking;
3) Dynamic conception of systems resulting from definition built on transformation processes (verb) not on given entities (nouns);
4) The methodology covers close circle and respect endless evolution of problem (system).

Also Checkland's concept of *system of human activities* reflects essential properties of organization and/or all organized human activities scilicet how adjust doing of individuals. This problem has wider context connecting with the (circular) unity of human knowledge and action. Maturana and Varela this association voice as: *All doing is knowing and all knowing is doing*' [Maturana & Varela, 1998, p. 27]. These problems have also others facets relating primarily to the generation of single and realized knowledge. This opens other question such as dilemma of the selection of best knowledge or correct/precise knowledge at least. And other issues as follows: *Have and/or do share participating people this knowledge? Is such embedded knowledge appropriate for changing situation?* These questions having universal relevance are acute also for soft systems methodology and involve problem how choose/create one from many root definitions.

## Systems and Concepts

If both disciplines – system science and cybernetics – have had similar rudiments at early stage, their consecutive expansion and advancement would discriminate against each other? Cybernetics principles, briefly sketched in figure, were exploited in technical field and have came normal ingredient of engineering matters. For many discipline itself has receded into the background (some consider cybernetics to be dead) while for some (namely for authors of sci-fi literature) it has become foggy synonym for future progress. In this sense cybernetics is perceived by wider community a thought deep domain of initiates fondly connected with (technological) progress. Similar conception survives also among many people from professional communities who don't understand its advanced ideas. On the other hand system science has observed a success – at least if an extensive and misty usage of systems terminology can be regarded as a success. The term systems is extremely popular in many spheres of human live, while its real nature (principles) remain misunderstood. To characterize reason why system thinking isn't applied consistently Hitchins has criticized systems engineers that '*(many of them) don't believe into system principles'* Hitchins, 1992].

To remember wider pattern of thought mentioned above we can chalk out various concepts of system derived from individual's assumptions (ses Figure 2).

Probably the most important distinction in perceiving the sense of systems lies in the gap between ontology and epistemology. Mentioned problem epitomizes recognized variance between real entity (object) and system as its thinking (concept). In other words: Real systems do not exist actually, they are just the human notion of regarded domain including individual intention. Klír [1991, p. 12] argues expressively:

> *... systems do not exist in the real world independent on the human mind. They are created by the acts of making distinctions in the real world or, possibly, in the world of ideas. Every act must be made of some agent, and, of course, the agent is in this case the human mind, with its perceptual and mental capabilities.*

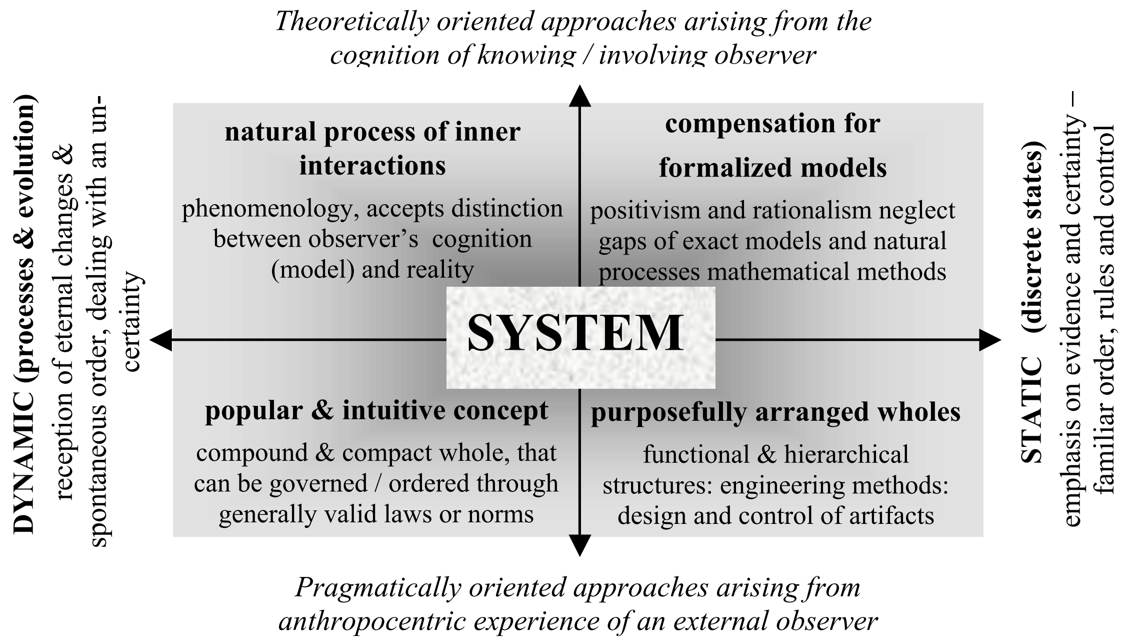


Figure 2. Different conception of systems depending on (some aspects) of worldview.

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Despite this we should critically face the fact that early hope and expectations were not saturated / fulfilled and advanced systems thinking is accepted just hardly and with hesitancy. Perhaps it is more obvious in post-totalitarian countries however significance of systemic ideas deserves higher appreciation all over the world. Probably the greatest disillusion dominates in managerial area in which a high expectation was connected with scientific management in sixties. This conception was based rather on systems terminology than understanding the principles as well as methodology that was focused on analysis while synthesis was derived from exact relationships of deterministic models and/or exact formulas. Many other 'schools' and 'theories' were connected with what was a nice expectation and was also connected with promises and tools that would have to warrant success from that time. Let us remember at least some of them:

System's concept generally and also defined systems by itself are expression of a particular human intelligence, knowledge and investigation. They are an abstract epistemological category, built upon our knowledge through a suitable 'systems language' [Wilson, 1992]. To understand them well we must understand our own intrinsic knowledge and/or world-view first of all.

In this place we probably understand newly emergent unity of system science and second order cybernetics and most important aspect (not only) of it. Dichotomy of the real (material) world and view of world – the way through we understood to the universe. However such disclosure is far from duality and point out to unity of the observer's faces: human being (material world) on the one side and human knowing (world of awareness and ideas) on the other side. Despite any anthropocentric fancy human being is an "animal" that is invest with self-consciousness and/or *animal symbolicus* [Cassier, 1929]. If all assumptions coupled with human anomaly resulting from the being of (misty and mysterious) self-consciousness fall since sixties however one survives. It is ability of abstraction and to use symbols - or better - language that represents systems of the symbols (words) and syntax enabling constitution concepts and an announcement of infinite ideas.

Process of abstraction is immediately connected with human being and its role growths together with increasing knowledge and has an extreme emphasis in the domain of system thinking [Gigch, 1991]. In contrast to empiric cognition it does not come from sensual reception of material world (sensation) and results from two different processes:

1) Generalizing abstraction ignores material reality (particular) and forms conceptual (intangible) patterns coupled wit symbols (signs). Anthropic quality is constituted through a set of empirically distinguished properties.
2) Idealizing abstraction comes from reflection on elusive phenomena emerging from processing. Preferring wider context we attribute different properties and quality to them and inscribe them with different signs coupled with appropriate concepts (ideas). .

In the second case considered entities cannot be verify through empiric investigation, but we can attest them through the explanation. In this way many new concepts emerge in systemic domain and some of traditional terms change the actual meaning. Also variety of different conception seems to be clear from this position as well as our different activities derived from them.

**Advanced systemic thinking and knowledge**

Recent advancement in system science is connected with principles of self-organization as possibility to change (system's) identity spontaneously. Contemporary second order cybernetics points to the double nature of the human being – the first is particular individual as organism (biological system) and the other is an observer constituting his (internal) knowledge. This distinction corresponds also with advanced systems theory that emphasizes nature of reflected systems and spontaneous order (cosmos) comparing it with human ideas and embedded order (taxis) and our participation on evolutionary process through this way.

Fifty years of the advancement of both disciplines treat abstraction by two different ways: On the one side it points out some simplified premises implicitly inherent within many theories that are out of real (material) world. On the other side it fetches many new abstract concepts and moves the meaning of many traditionally (rather familiarly) understood ones. On their basis it explains many phenomena and processes newly without misty aspects and mystifying legend. However small distinctions within basic concepts produces (can produce) great (sometime essential) difference in the constitution of whole ideas, knowledge and thinking as well as doing. Some difficulties of mutual intellection emerge among people from systemic domain. But great problems arise from interpretation (new) systems terminology through old or insufficiently understood concepts often arising from traditional world-view mentioned above.

Systemic ideas branches to wide field covering many (more or less new) terms & concepts and a few important theories. Let us remember just some of them:

Theory of dissipative structures, chaos theory, autopoiesis, synergy at side of major theories and new concepts as: dissipation, attractor, bifurcation, organizational closure, pattern, dynamic equilibrium… And remember other terms expressively changing their meaning: evolution, information, knowledge, system… To be aware of limits of this article of as well as my understanding I would like briefly present some systemic principles selected with regard to my intention and presented conception:

- **Evolutionary conception** explains material and innate nature of world, including cognitive processes, typically in modern interpretation of knowledge and/or knowing. It exceeds the Darwinian theory of slow adaptation and explains natural evolution as self-organization (incl. the concept of deterministic chaos)
- **Recursivity** is the result of circular action of feedbacks and points out the fact that evolution of corresponding systems depends not only on the inputs effect, but also on the preceding states (preceding evolution) of the system itself. It also explains narrowed conception of traditional linearity in the sense of causal chain in which output becomes input (that becomes next output again…).
- **System hierarchy** usually emphasises, that system components are systems again and vice versa every system is a part of broader „supra“ system. This fact refers to mutual dependency between parts and the whole, like their mutual interaction. It’s result is symbiosis (or recondition) of whole universe, as an environment for the existence of natural (material) world.
- Conception of **dynamic equilibrium**, in which the physical structures are kept, and these structures have the nature of cyclical attractors. From the observer’s point of view discrete states of system fluctuate around (abstract) patterns and the number and amount of fluctuations contribute to possible (revolutionary) change, associated with the conception of emergence.
- **Chaos and complexity** understood alternatively from two mention view: From anthropic position it is understood as a failure of the known order enabling an insight of the observer. From systemic position it is a evolutionary stage between two states of dynamic equilibrium. Chaos theory introduces the concept of attractors as (spatial) trajectories and points out the ‘*butterfly effect*’ in which an inconsiderable incident can do unexpected changes. These changes don't have deterministic nature and depend on dynamic processes of extensive interactions.

Some difficulties of systemic thinking are also raising from emergent unity of system science and cybernetics are advanced through, different terminology and nature (complexity) of observed (considered) phenomena. Typically we can mention both major theories: theory of dissipative structures and autopoiesis hat tries to solve similar problems in similar manner.

The theory of dissipative structures is primarily focused to physical (non-living) systems and looks at energy – its flows through the universe and/or interchange among (considered) systems. It explains an essential reduction resulting from abstraction that ignores this reality and deduces theories from the concept of closed systems resulting to second law of thermodynamics. Implicit and misjudged or unknown assumptions lead to the idea of (natural and progressive) disorganization. However Prigogine [Prigogine & Stengers, 1984] has returned to reality and considers possible situations *far from equilibrium* and has proved possibility of self-organization as well as emergence of new and more complex structures (systems). Also chaos theory evolves this ides and focus on the importance of systems and processes being situated *on the edge of chaos*. Both disciplines uses new and important concepts of attractors as a possible trajectory or rather fitness landscape of really potential but not determined evolution.

On the other hand autopoiesis is the question of self-maintenance of systems, that is explained using processes, that are in progress in biological structures. It is oriented rather to maintenance and/or self-production of structures and explains the nature of living systems. Using such concepts as *organizational closure* and *structures* compared with *pattern* it explains other aspects of the evolution of whole universe [Laslo, 1999]. It is possible to connect it with consistently reflected *systems hierarchy* and/or notion of *orchestration (within the universe) and also* conception of *symbiosis* (*symbiotic planet*) [Margulis, 1998]. The natural implication of such evolution is an emergence of human (observer's) cognition and possibility to share and evolve it within a social environment through language.

Let us notice an essential affair: Both theories are originally rooted in real – material world: The first outlines the evolution (newly) as connected with an emergence of more complex structures / systems including autonomous and material nervous systems (rather than commonly used concept of brain). The other points at the extremely complex structures an emergence of ideas and concepts emerging from including processes of self-organization (not simple self copying). To outline this threshold better we can point out some newly understood facts of the nature of knowledge:

- Biological nature of knowledge explains its real nature and its core aspects: First of all it's the dynamic nature of cognitive process that is linked to biological organism. The circular relation of implicit knowledge of individual and semantic or conceptual information. The information results from externalization using language and through the language it is shared in social system.
- The knowledge emerges from an singular interaction of (material) observer - organism within his environment and constitutes coupling of patterns. Some from states (attractor basins) of these processes are connected with symbols being able represented by (material) signs. Through this way such knowledge (or better *piece of knowledge*) becomes communicable within social systems. Its communication (rather sharing) enables next level of abstraction including more general concepts and culturally constituted frameworks backwardly influencing observer's knowledge. To accept this social process Winograd and Flores [1986] use term

individual knowledge – it is strictly embodied within organism but it is socially constructed [Kuhn, 1962] by the same mail??.

- Finally let us stress knowledge's intentional nature and also fitting statement *knowledge is justified true belief* [Nonaka, 1995]. The recursive nature of feedback also affects the circular relationship between (former/earlier) knowledge and the process of its change. It implies important fact – our knowledge is formed in past, but affect our actions and activities, that result in consequences in future.

These facts or better knowledge point out the importance of concepts as important (not only one) building blocks of human cognition. However the traditional concept of block is not sufficient in this cases – concepts fluctuate and actual meaning depends on (1) individual knowledge of the interpret (2) its intention and finally (3) on actual (actualized) context. Moreover language as well as concepts does not play an essential role only in communication but also in the nature of human knowing, thinking and doing also (primarily?).

## Conclusion

The circularity of knowledge and system science seems to be explained through this way. It covers an explanation of human knowing in the one direction and meaning of knowledge (and basic concepts) backwardly. It points to the dichotomy of observer and the significance of correct (?) knowledge for human doing and his participation in the process of evolution an at the same time. To understood systemic ideas consistently we should accent seldom mentioned fact concerning relatively new aspect of evolution and our influence on it:  a huge amount of energy from fossil sources. In this way we use energy far behind natural circulation and dramatically speeding up the evolution, the profundity of running changes and – being on the edge of chaos – also their irreversible nature.

The concept of evolution is based on principles of self-organization and also human cognition (knowing rather tan knowledge) is explained from biological (material) position… Different knowledge and meanings, arising from different individual knowledge (in particular context) proceeds occasion at fluctuations in human systems but they are the natural source of their spontaneous order and/or self organization. Ulrich [1994] distinguishes purposeful systems from concepts of living (organic) systems and argues:

> *The internal variety generation of social systems is inextricably rooted in the semantically and pragmatically meaningful experience of subject.*

In other words: Resulting complexity of a human system arises from the various and singular character of interpreted information resulting from the same received information (the associated data and signals). Various and changeable meaning of human information and consequent actions characterize system's fluctuations and create an environment for its dynamic evolution and self-organization. Therefore, the system is out of control in a deterministic sense and needs rethinking the concept of organization based upon linear order. Accordingly we must try to understand the notion of organization as a process of organizing systems rather than its state or structure.

Let me accent two ideas resulting from presented theory concerning globalization of these days from newly viewed point:

Firstly it is changing complexity that comprehends two opposite trends: Due information technology we communicate dramatically increased amount of data (signs) that are interpreted by particular people (with individual knowledge). In the same time also amount of fluctuations emerges including growing uncertainty and turbulence as well as possibility of spontaneous changes. On the other side we embed increasing amount of knowledge into various systems – from artifacts (incl. computer based IS) across mass-media (incl. internet) to unified systems of education. On this basis we increase organization within the society and build greater/larger systems that are less adaptable for unexpected changes within an environment.

Secondly we should consider the problematic nature of human knowledge and resulting foolish idea of truth and objectivity. Gap between real world and our recognition of it is typical for a constructivist view of contemporary system science, and goes on increasingly. Systems don't exist away in time or place: actually system is what is distinguished in our cognition - it is an abstract. In effect the abstraction produces disparity in comparison with reality – it generalizes and effaces singularity (difference and fluctuation). However exactly the '*difference is a most important concept of cybernetics*' [Ashby, 1956]. In consequence system is an epistemological phenomenon and we must take high focus on origin, structure, acquisition and validity of knowledge upon which are built our system's models. We live within two realities - the first is the reality of material world however the second is social or socially created reality [Berger, & Luckman, 1966]. The increasing difference between them coupled with an unreal fantasy of western humanity brings newly perceived problems (for example problems of 'social state/government') and can be fateful shortly.

Appropriate issues are one of fundamental aspects of (increasing) complexity of the global world… The adoption of basic systemic theory gives a suitable opportunity to act better and more responsibly in the sense future anticipation. However these ideas are too abstract (theoretical) for many pragmatically thinking people… What can/must we do?

## References


Ashby R. [1956]: *An Introduction to Cybernetics*, Chapman Hall, London;

Berger, P. & Luckman, T. [1966]: *The Social Construction of Reality. A Treatise in the Sociology of Knowledge,* Doubleday, New York.

Cassier, E. [1929]: Philosophie der Symbolischen Formen, Bd. 1-3, Berlin;

Checkland,P., [1981]: *Systems Thinking, Systems Practice*; J. Wiley, London;

Hayek, F.A., 1979, *Law, Legislation and Liberty*, Routlidge, London (Czech: Academia, Praha 1991.

Hitchins, D. [1992]: *Putting Systems to Work*, J. Willey, New York;

Kampis, G., [1991]: Self-modifying Systems in Biology and Cognitive Science," Pergamon Press, Oxford, (1991).

Klír, G. [1991]: *Facets of Systems Science, IFSR International Series on Science and Engineering*, Pergamon Press, Oxford, Laszlo, E. [1999]: The Systems View of the World; Hampton Press, Cresskill, NJ;

Margulis, L. [1998]: *Symbiotic Planet. A New View of Evolution*, Basic Books, New York;

Nonaka, I. [1995] *A Dynamic Theory of Organizational Knowledge Creation*, In: California

Prigogine, I. [1980]: *From Being to Becoming: Time And Complexity in the Physical Sciences*, Freeman, San Francisco;

Prigogine, I. & Stengers. I. [1984]: *Order Out of Chaos – Man's New Dialogue with Nature*, Bantam Books, New York;

Stanford Encyclopedia of Philosophy [2005], URL:
http://plato.stanford.edu/contents.html#k;

Rosicky, A. [2002]: *Information Generating System*, in: ESCMR, Vienna;

Ulrich. W. [1983]: *Critical Heuristic of Social Planning*, Wiley, London;

Weaver, W. [1948]: *Science and Complexity*, American Scientist, vol 36, 1948;

Wiener, N. [1948]: *Cybernetics or Control and Communication in the Animal and the Machine*, MIT Press, Massachusetts.

Winograd,T. and Flores, F, [1986], *Understanding Computers and Cognition*, Ablex Pub. Norwood;