ITHEA

International Journal
INFORMATION THEORIES & APPLICATIONS

2011 Volume 18 Number 2

International Journal
INFORMATION THEORIES & APPLICATIONS
Volume 18 / 2011, Number 2

Editor in chief: **Krassimir Markov** (Bulgaria)

Victor Gladun (Ukraine)

Adil Timofeev	(Russia)	**Luis F. de Mingo**	(Spain)
Aleksey Voloshin	(Ukraine)	**Lyudmila Lyadova**	(Russia)
Alexander Eremeev	(Russia)	**Martin P. Mintchev**	(Canada)
Alexander Kleshchev	(Russia)	**Natalia Bilous**	(Ukraine)
Alexander Palagin	(Ukraine)	**Nikolay Zagoruiko**	(Russia)
Alfredo Milani	(Italy)	**Rumyana Kirkova**	(Bulgaria)
Arkadij Zakrevskij	(Belarus)	**Stefan Dodunekov**	(Bulgaria)
Avram Eskenazi	(Bulgaria)	**Stoyan Poryazov**	(Bulgaria)
Boris Fedunov	(Russia)	**Tatyana Gavrilova**	(Russia)
Constantine Gaindric	(Moldavia)	**Valeriya Gribova**	(Russia)
Galina Rybina	(Russia)	**Vasil Sgurev**	(Bulgaria)
Georgi Gluhchev	(Bulgaria)	**Vitalii Velychko**	(Ukraine)
Hasmik Sahakyan	(Armenia)	**Vitaliy Lozovskiy**	(Ukraine)
Ilia Mitov	(Bulgaria)	**Vladimir Donchenko**	(Ukraine)
Juan Castellanos	(Spain)	**Vladimir Jotsov**	(Bulgaria)
Koen Vanhoof	(Belgium)	**Vladimir Ryazanov**	(Russia)
Levon Aslanyan	(Armenia)	**Yevgeniy Bodyanskiy**	(Ukraine)

International Journal "INFORMATION THEORIES & APPLICATIONS" (IJ ITA)
is official publisher of the scientific papers of the members of
the ITHEA International Scientific Society

IJ ITA welcomes scientific papers connected with any information theory or its application.
IJ ITA rules for preparing the manuscripts are compulsory.
The **rules for the papers** for IJ ITA as well as the **subscription fees** are given on *www.foibg.com/ijita*.

Responsibility for papers published in IJ ITA belongs to authors.

General Sponsor of IJ ITA is the **Consortium FOI Bulgaria** (www.foibg.com).

International Journal "INFORMATION THEORIES & APPLICATIONS" Vol. 18, Number 2, 2011

Printed in Bulgaria

Edited by the **Institute of Information Theories and Applications FOI ITHEA**, Bulgaria, in collaboration with:
V.M.Glushkov Institute of Cybernetics of NAS, Ukraine,
Institute of Mathematics and Informatics, BAS, Bulgaria,
Universidad Politécnica de Madrid, Spain.

Publisher: **ITHEA**
Sofia, 1000, P.O.B. 775, Bulgaria. www.ithea.org, www.foibg.com, e-mail: info@foibg.com

Copyright © 1993-2011 All rights reserved for the publisher and all authors.
® 1993-2011 "Information Theories and Applications" is a trademark of Krassimir Markov

ISSN 1310-0513 (printed) **ISSN 1313-0463 (online)** **ISSN 1313-0498 (CD/DVD)**

WU KUN AND THE METAPHILOSOPHY OF INFORMATION

Joseph E. Brenner

Abstract: *At the 4th International Conference on the Foundations of Information Science in Beijing, August, 2010, Professor Wu Kun of the Xi'an Jiaotong University presented, for the first time in English, the results of some thirty years of research on the theory and philosophy of information. In particular, Wu's theory (Basic Theory of the Philosophy of Information; BTPI) focuses on the natural ontological properties of information, and their importance for a proper understanding of the function of information in society. When describing my recent extension of logic to real process systems (Logic in Reality; LIR), including information, at the same Conference, I noted that Wu's approach embodied many critical aspects of this logic, to which its normative principles apply.*

In this paper, I provide a summary of the Wu Basic Theory that defines a Philosophy of Information as a Metaphilosophy. The latter is not directed toward the codification of such a metaphilosophy as yet another static discipline or body of knowledge. It is rather an attitude toward the positioning of information as encompassing a critical component of all disciplines, beyond the scientific content specific to them. The Metaphilosophy of Information, then, describes primarily an attitude or stance, which I have termed the Informational Stance, that requires attention to the informational aspects of complex processes as a methodological necessity, in a process that Wu calls Informational Thinking. The Informational Stance, in my view, is thus a philosophical stance that is most appropriate for, and above all not separated nor isolated from, the emerging science and philosophy of information itself, for which I show that Logic in Reality is the appropriate logic.

My major conclusion is that the BTPI of Wu, his new informational view of the need for unification of critical disciplines and their formulation as a metaphilosophy constitute a major contribution, as yet unrecognized outside China, to the General Theory of Information that is the subject of this Conference. The theories described in this paper may constitute part of a new transdisciplinary paradigm, in which information has a central role. Application of my interpretation of logic together with Wu's metaphilosophy of information could contribute to resolving critical outstanding issues in the field of information and provide further support for an ethical development of the emerging Information Society.

Keywords: *ethics; information; logic; metaphilosophy; process*

INTRODUCTION

The Basic Theory of Wu Kun

At the 4th International Conference on the Foundations of Information Science in Beijing, August, 2010, Professor Wu Kun of the Xi'an Jiaotong University presented, for the first time in English [Wu, 2010], the results of some thirty years of research on the theory and philosophy of information. In particular, Wu's theory (Basic Theory of the Philosophy of Information; BTPI) focuses on the phenomenological structural and functional properties of information, and the importance of a proper understanding of information for the emerging Information Society.

Perhaps even more importantly, Wu emphasized the concept of information as a basic category of philosophy, defining the central role of information and information science in all relevant disciplines such as ontology and

epistemology as well as in science. This is a metaphilosophical principle, since it has to do with the content of philosophy itself. Justification for Wu's calling his Philosophy of Information a Metaphilosophy, "a highest philosophy", to be distinguished from all others, is its unique and universal character, its new worldview, as an informational conception of history, society, values, knowledge, science and technology.

Wu sees the field of information science as a complex of the philosophy of information, general information theory and different sub-domains of practical application in all of which he has made contributions. The full assessment of Wu Kun's work and its implications for both philosophy and the philosophy and science of information must await its complete translation into English. Although it is clear that his work provides a major new perspective on the complex ontological properties of information, discussion of all these fields is not possible in this paper, and I will focus primarily on the "umbrella concept" of the Metaphilosophy of Information.

Support for the key phenomenological concepts developed by Wu has come from my recent extension of logic to real process systems (Logic in Reality; LIR), including information [Brenner, 2008]. I noted that Wu's approach embodied many critical aspects of this logic, to which its normative principles apply. I am grateful to Professor Wu for his valuable comments and additions to this paper.

Outline of Paper

I am convinced that the Philosophy of Information in Wu's conception is at the heart of a new informational paradigm or informational-ontological turn. In Section 1, I suggest a content for that paradigm, including the possibility of a general theory of information involving philosophy, logic and ontology that embodies a transdisciplinary perspective. Section 2 compares my approach with other recent approaches to information as further indication of the unavoidable complexity of any even partially satisfactory definition. Section 3 returns to the specifically metaphilosophical concepts of Wu as essential to understanding the dynamics of the social and ethical dimensions of information.

Regarding methodology, the reader will see that I have not always maintained a clear distinction between a theory, logic and philosophy of information, while at the same time trying to avoid conflating them. I believe that in fact, as one consequence of the principles of Logic in Reality, such disciplines are not totally separated or separable, and their overlap or epistemic interaction is more significant than their differences. Indeed, one of Wu's proposals is for using information science as a basis for a Unified Information Theory that could lead to a unity of knowledge.

1 THE CONTENT OF A NEW PARADIGM

1.1 Progress in Philosophy and Logic

The major focus of a Conference to be held soon after this one[1] will be the kind of philosophy and logic that is appropriate for new technology, in particular, the new Information and Communication Technologies (ICTs). Luciano Floridi has stated [Floridi, 2010] that the ICTs have achieved the status of the characteristic technology of our time: the computer and its related devices constitute a "culturally defining technology". Information and

[1] 12th Conference on the Logic, Methodology and Philosophy of Science, Nancy, France, July, 2011.

Communications Systems (ICSs) and ICT applications are among the most strategic factors governing science, the life of society and its future directions of development.

Progress in science and technology is thus accepted as real, but the nature of progress in philosophy, if any, is unclear. New logics continue to be proposed, but on close inspection they all follow a standard propositional, truth-functional form, without the ability to describe complex processes and phenomena such as information without substantial reduction of its essential properties.

On the other hand, as Floridi and Rafael Capurro [Capurro, 2008] have shown, the availability of the ICTs has increased the coupling between social and political processes and the underlying philosophical paradigm. A responsible philosophy of information thus becomes an essential component for the elaboration of morally responsible public policy.

The Basic Theory of the Philosophy of Information (BTPI) presented by Wu Kun focuses not only on the phenomenological structural and functional properties of information, but the importance of a proper understanding of it exactly as the basis for movement to a more democratic society. I may consider that the body of Wu's work in information constitutes progress in philosophy, as does that of the other authors referred to below.

As I showed elsewhere [Brenner, 2010], however a satisfactory Philosophy of Information also requires an appropriate logic, and logics applicable to the new informational-technological context are simply not available. [Franssen *et al.*, 2010] summarize the Philosophy of Technology but say nothing about a logic of technology. Ellul [Lovekin, 1977] saw the "logic of technology" as a "closed, viciously idealistic" reductive form of thought that required humanization by the inclusion of non-identities. Further, Capurro states [Capurro,1996] that technology is "non-neutral", and standard logics are virtually required to be topic-neutral and context-independent.

As a first step, Floridi's development [Floridi, 2006] of a *logic* of and for information (Information Logic; The Logic of Being Informed) filled a major gap in the effort to characterize information, since standard epistemic and doxastic logics fail to capture its essential characteristics. The new Logic in Reality (LIR) proposed by Brenner is a new, non-propositional kind of logic that extends the domain of logic to real processes. Applied to the remaining open problems in information to which Floridi has called attention [Floridi, 2004], it constitutes an even more radical change in a logical approach for their solution. On overview of the key principles of LIR is provided below in Section 1.3.

1.2 The Basic Theory of Wu Kun

1.2.1 The Existential Field

The basic insight of Wu Kun's Philosophy of Information is that the concept of objective reality = objective existence is too poor to describe the informational world. A proper new ontology and worldview is needed to describe the phenomenological characteristics of that existence. The approach of Wu to information is to start with existence as so constituted as objective and subjective from a phenomenological standpoint. He then places the critical terms of existence, objective and subjective, reality and unreality, and direct and indirect in a framework or partition diagram in which each combination of terms defines a path leading to matter-energy on the one hand and information on the other. Restating his key conclusions, information then has the following characteristics:

- Information has an indirect existence that is both objective and subjective.
- Subjective indirect existence is derived from subjective unreality that is part of subjective existence (human individuality).
- Objective indirect existence derives from objective unreality that is nevertheless part of objective existence.

Existence is constituted in this picture, then, by *both* matter-energy and information from a physical perspective. I thus conclude the essence of information, namely that it is "tied" to existence and reality through its objective and subjective aspects. It *is* those aspects. Hence all entities are characterized as dualities of matter-energy and information. The complexification that occurs in moving from one informational form to the next is readily interpreted in terms of grades or levels. The concept of information as indirect but still material existence enables Wu to show that any object is constituted by its directly and indirectly existing parts, material and its history, present structure and future structure which taken together constitute an informational entity or in Wu's term an "informosome" (see Section 2.1.1 below). This descriptive resegmentation of the field of existence (the extant domain) of Wu, when applied to informational processes or 'activities' benefits from the principles of LIR that further explicate their normative and qualitative properties.

1.2.2 The Classification and Structure of Information

Wu then classifies information into three independent forms and one dependent form:

- In-itself information

  In-itself information has an objective indirect existence not mediated by any subject. It is constituted by the basic particles of matter-energy and their fluctuations, which in turn constitute the Informational Field (IF). The IF has a direct existence and an indirect existential unity. The interactions taking place in the IF involve all entities in processes of information transmission and reception. In-itself informational activities are the most fundamental from which all others are derived. It includes, but is not limited to, information a well-formed, meaningful data in the view of Floridi.

- For-itself information

  For-itself information is the consequence of the grasp and processing of in-itself information by a subject with the necessary mental-psychological capacities, giving it subjective indirect existence. Wu designates this subject as the "informational subject".

These two categories recall Sartre's division of being into the categories of in-itself (*en-soi*) and for-itself (*pour-soi*). I cannot pursue further here the complex origins and roles of these categories, except to say that they offer a way of talking about existence that is compatible with a concept of intrinsic information and of its processing.

- Regenerated information

  Regenerated information is the consequence of creative informational activities operating on for-itself information by the informational subject resulting in higher-level concepts, images, symbols, *etc.* The complex of all such information in the individual is what is usually referred to as "mind" or spirit, whose existence is also subjective and indirect.

- Social information

  Social information is a dependent form of information constituted by the triple of in-itself, for-itself and regenerated information, in which the second two, involving information creation and processing by humans, are the most important. Social information undergoes its own process of "evolutionary" development.

1.2.2 The Informational Field

Wu's concept of an informational field further defines the essence of information. The field is multidimensional, including the various functions, roles, structures and relationships involved in the production, transmission and reception of information. From the standpoint of LIR, all of these entities, especially structures, must be looked at as causally effective processes. Lupasco used the term structuration, "*structuration*" in French, to emphasize the dynamic *process* aspects of complex structures, biological, cognitive or social. The answer he gave to his own question "*What is a structure?*" [Lupasco, 1967] was that structures are also dynamisms, not to be objectified and reified. In the LIR perspective, structuration is a real operation on the relations between two individuals. Any individual structure is never rigorously actual, that is, absolute in any sense, given the nature and logic of energy. It is a dynamic "structuring" that is always functionally associated with an antagonistic and contradictory potential structuring. Another way of saying this is that a structuring seen externally is a kind of form; looked at internally, it consists of the processes themselves.

In the remainder of this paper, I will continue on the basis that the principles of LIR in fact support to the descriptive resegmentation of the field of existence (the extant domain) by Wu. LIR makes it "logical" to talk about interactive relations between objective and subjective, reality and unreality, internal and external, direct and indirect and so on, and it does not exclude *a priori* the existence of real contradictions. LIR formalizes and explicates the absence of separation noted by Wu, retaining the consequences for information. For LIR, its "unreality" is only apparent since all information – as sent or received – is the effect of some real causal process. When applied to informational processes or 'activities', it aids in the explication of their active non-quantitative and normative properties and the evolution of the latter in their transmission, reception and interpretation.

As indicated in Section 1.3 below, LIR basically defines information as a process as the reality in a physical space of a dialectical relation between sender and receiver, in which meaning and value emerge due to the constraints on the evolving interactions [Brenner, 2009]. The conception of information-as-process is central to both the BTPI and LIR views. As stated by Quieroz [Quieroz *et al.*, 2008], the processual approach to information departs from the treatment of information as contained in some (static) structure, and moves toward an understanding of information as a semiotic process, a Peircean semiosis. In the next Section on current topics in information, however, among other things, I will return to the problems associated with the semiotic approach.

1.3 Logic in Reality and Information-as-Process

Logic in Reality (LIR) is a new, non-propositional kind of logic that extends the domain of logic to real processes. LIR is grounded in a particle/field view of the universe, and its axioms and rules provide a framework for analyzing and making inferences about complex real world entities and interactive processes at biological, cognitive and social levels of reality or complexity.

The term Logic in Reality (LIR) is intended to imply both 1) that the principle of change according to which reality operates is a *logic* embedded in it, *the* logic in reality; and 2) that what logic really *is* or should be involves this same real physical-metaphysical but also logical principle. The major components of this logic are the following:

- The foundation in the physical and metaphysical dualities of nature
- Its axioms and calculus intended to reflect real change
- The categorial structure of its related ontology
- A two-level framework of relational analysis

Details of LIR are provided in [Brenner, 2008]. Stated rapidly, its most important concepts are that 1) every real complex process is accompanied, logically and functionally, by its opposite or contradiction (Principle of Dynamic Opposition; PDO), but only in the sense that when one element is (predominantly) present or actualized, the other is (predominantly) absent or potentialized, alternately and reciprocally, without either ever going to zero; and 2) the emergence of a new entity at a higher level of reality or complexity can take place at the point of equilibrium or maximum interaction between the two.

LIR should be seen as a logic applying to processes, in a process-ontological view of reality [Seibt, 2009], to trends and tendencies, rather than to 'objects' or the steps in a state-transition picture of change. Processes are described formally as transfinite chains of chains of chains, etc. of alternating actualizations and potentializations of implications, considered with the other logical operators, conjunction and disjunction as real processes themselves. The directions of change are either 1) toward stable macrophysical objects and simple situations, the result of processes of processes, etc. going in the direction of a "non-contradictory" identity or diversity: or 2) toward a state of maximum contradiction (T-state for included third term) from which new entities can emerge. LIR is, therefore, a logic of emergence, a new non-propositional, non-truth-functional logic of change.

Standard logic underlies, rather, the construction of simplified models which fail to capture the essential dynamics of biological and cognitive processes, such as reasoning [Magnani, 2002]. LIR does not replace classical binary or multi-valued logics but reduces to them for simple systems and situations. The interactive relationships within or between levels of reality to which LIR applies are characteristic of entities with some form of internal representation, biological or cognitive.

In contrast to standard logics, LIR has no difficulty in accepting inconsistency, interpreting it as a natural consequence of the underlying oppositions in physical reality. Many if not most of the problems in the (endless) debate about the nature of change, as pointed out by Mortensen [Mortensen, 2008], seem to require a fundamental inconsistency in the world, which LIR naturalizes. Logic in Reality, then, is an information system that is not "brittle, like a classical logic system" [Floridi, 2010] in the presence of an inconsistency. Inconsistency is in the former is not only not as destructive as in the latter, but is accepted as an essential part of its ontology.

1.3.1 Information in LIR

Logic in Reality does not pretend to offer or to constitute an independent theory of information that would supersede any or all existing approaches. LIR provides a new interpretation of the concept of qualitative information or information-as-process [Brenner, 2010] as contrasted with quantitative information. Given its contradictorial approach to all complex real phenomena, LIR can be seen as a method, a logical methodology

that would encourage the retention and use of partially conflicting notions and theories of information, among others.

Among the key open problems in the philosophy of information, Floridi [Floridi, 2004] includes several concerning the relation between information and the actual world. Thus, information can be viewed from three perspectives: information *as* reality (e.g. as patterns of physical signals, which are neither true nor false), also known as *environmental* information; information *about* reality (semantic information, alethically qualifiable); and information *for* reality (instructions, like genetic information, algorithms, orders, or recipes).

Many extensionalist approaches to the definition of information *as* reality or *about* reality provide different starting points for answering the question of what information *is*, but the broad theory of information proposed by Wu requires an understanding of the properties and role of information at all levels of reality, in all entities. Whatever contributes to this understanding must accordingly be valuable for philosophy in general, and I propose this paper as a clarification of the relevant *ontological* properties of information.

The definition of information that is most congenial to LIR was made by Kolmogorov [Mindell, Gerovitch 2003] to the effect that information is any operator which changes the distribution of probabilities in a given set of events. This is quite different from his well-known contribution to algorithmic information theory, but fits the process conceptions of LIR. In LIR, logical elements of real processes resemble (non-Kolmogorovian) probabilities, and the logical operators are also processes, such that a predominantly actualized positive implication, for example, is always accompanied by a predominantly potentialized negative implication. It is possible to analyze both information and meaning (higher level information [Brenner 2010a]) as having the potential or being a mechanism to change the informational context.

LIR thus can provide bridging concepts or 'glue' between a concept of semantic information at the lowest data level and the broader applications. LIR places this concept, and thus the "superconcept" [Hofkirchner, 2009] of information, in a naturalized physical, metaphysical and logical context. Information is both a means to model the world and part of the world that is modeled, and LIR describes the dialectic relation between them.

1.3.2 Logic in Reality as Metalogic

Logic in Reality, as should be clear by now, is a new way of 'doing logic' that is much more radical than a change in the established object-process-property terminology. This is a metalogical consideration, since it discusses the logic of a logical system and the major components of that system, its rules and relations.

The metalogical properties of LIR are based on a view of nature that does not consider fundamental either to the abstract entities of pure classical propositional or mathematical logic or the anthropomorphic ontological concepts of phenomenology. The most fundamental metalogical principle of LIR is that of opposition or antagonism, without which, in this view, nothing could exist. This is, therefore, at the same time the most fundamental metaphysical principle of LIR. Nothing exists independently of something else in the formal ontology of LIR.

1.4 The Transdisciplinary Hermeneutics of Information Science

As I among many others have noted, the understanding of information requires knowledge in a multitude of different disciplines, and one way of bringing some order into this complex system is to introduce the concept of transdisciplinarity. Transdisciplinarity, in the universal definition of Nicolescu [Nicolescu, 2002], head of the International Center for Transdisciplinary Research in Paris, concerns that which is at the same time between, across and beyond all disciplines, the things they have in common. Its objective is the comprehension of the current world, of which one of the imperative necessities is a unity of knowledge. It is a theory that places the human being at the center of its preoccupations, and, in my opinion, has greater generality and is the one more suitable to discussing issues in education, ethics and other aspects of social theory than more pragmatic, "problem-solving" conceptions.

The three conceptual "pillars" of transdisciplinarity in the Nicolescu acceptation are 1) levels of reality; 2) complexity; and 3); a logic of the *included* middle, from which LIR has been derived. The key relation between disciplinarity and transdisciplinarity is that disciplinary research tends to involve just one level of reality, while transdisciplinarity is concerned with the dynamics resulting from the interaction of several levels of reality or complexity at the same time. A good model is in the work of the sociologist, biologist and philosopher Loet Leydesdorff on the interactions between the economic, political and knowledge-based sub-systems of society [Leydesdorff, 2006] in his theory of the Knowledge-Based Economy.

Logic in Reality, as discussed, is a logic of transdisciplinarity in the acceptation of the Paris Group. It is therefore a natural candidate as an additional tool for research in information. The unique function of this logic and its ontology would be to establish the structure of the relationships between competing theories and disciplines and thereby bridge the gap between them. In this "logic of transdisciplines", disciplines such as humanities and social sciences are not conflated in a differentiated unity but are dynamically connected epistemologically, changing one another and giving the opportunity for the emergence of new concepts.

The distinctions made by Hofkirchner et al. between multidisciplinarity, interdisciplinarity and transdisciplinarity are fully consistent with LIR, and are in fact essentially the same as those laid out by Nicolescu in his *Manifesto* [Nicolescu, 2002].

In the Charter of Transdisciplinarity which was promulgated at the 1st International Congress on Transdisciplinarity held in Arrabida, Portugal in 1994. Article VII states that transdisciplinarity is not a new discipline, nor a new religion, new philosophy, new metaphysics nor a new science of sciences. It can be considered as a process, a logical framework, a logic of human experience, a rigorous way of thinking about the relations and implications between events and people's actions, a language and an approach. The deontology of transdisciplinarity is based on the inalienable rights of the inner person in the context of the irreducible scientific and cultural novelties of today's world. Transdisciplinarity is a coherent terrain in which effective political will can be transformed by and into poetical or artistic will, a true politics of civilization, a civilized politics.

Wu Kun had, of course, anticipated this development in the sense that his Philosophy of Information established the central role of information in all disciplines. Thus information is itself something transdisciplinary that lies within, between and beyond disciplines and is common to all of them. He describes his research over a period of many years as broadly related to the following: the nature of the philosophy of information; information ontology; informational epistemology; an informational theory of evolution; social information theory; information value theory; an informational theory of thinking (see below Section 3.3); information and self-organization and

complexity theory; information and virtual reality; and systems of information science, the whole constituting a new scientific paradigm and a basis for future trends. In fact, it is an essential consequence of my approach that some of the distinctions that have been made between these terms serve only to block their overlap and mutual reinforcement. If this result can be seen in relation to information, it may have further consequences for individual disciplines as well, in particular, in emphasizing their relevant properties for social progress.

I therefore conclude that *no* approach to information, other than at the lowest level of data, Shannon-Weaver information in which meaning is not (yet) present, can be made without recourse to a transdisciplinary methodology in which the complexity and different levels of reality addressed by the disciplines co-exist and interact in a system of which the logic is Logic in Reality. In the transdisciplinary interpretations of such interactions, I see the beginnings of the operation of a new informational paradigm that both leads to and is constituted by what I describe below as a Metaphilosophy of Information and the Informational Stance derived from Wu's research.

2 CURRENT TOPICS IN INFORMATION

2.1 The Philosophy of Information

As Wu himself remarked, Luciano Floridi must be considered one of the founders of the field of the Philosophy of Information, independently of Wu himself. Floridi's studies were crystallized recently in his *Philosophy of Information*, [Floridi, 2010], and their relation to Logic in Reality developed in my two papers indicated above [Brenner 2010, 2010a] The original motivation for the development of a Philosophy of Information (PI) by Floridi was in response to a broader perceived need to place the entire field of information and its technology on a sound intellectual basis, as captured in Floridi's definition: "The philosophy of information (PI) is the philosophical field concerned with (a) the critical investigation of the conceptual nature and basic principles of information, including its dynamics, utilisation and sciences, and (b) the elaboration and application of information-theoretic and computational methodologies to philosophical problems.

In the LIR approach to information, a firm distinction cannot be maintained between the various extensionalist approaches to the definition of information *as* reality or *about* reality: probabilistic, modal, systemic, inferential (epistemic) and semantic. (For details see [Floridi, 2010]). The semantic approach defines information in terms of data space: semantic information is well-formed, meaningful and truthful data, information at the lowest ontological level. LIR provides the basis for saying that there is no absolute disjunction between this level of reality and those to which the more complex concepts of information apply. Many proposals of ways to unify these concepts have been made, *e.g.*, the recent one of Hofkirchner [Hofkirchner, 2009]. His approach to a Unified Theory of Information (UTI) is to eliminate the absolute and in my view artificial separation between critical concepts of information in favor of a dialectical relationship similar to the ancient intuition of 'unity-in-diversity'. Specifically, his "UTI seeks a concrete-universal concept of information rather than an abstract one".

Logic in Reality provides three *new elements* in relation to these points:

- a physical and logical grounding for a dialectical approach to information that explicates the concept of 'unity-in-diversity';
- a basis for a real, dialectical interaction between levels of abstraction, such that information at any level shares *some* of the properties to *some* extent of the structure of the information at the levels above and below it;
- a focus on information that is complex and value-laden which, unlike simpler data, is not easily decoupled from its support.

LIR can provide bridging concepts or 'glue' between the concept of semantic information that Floridi carefully and completely defines at the lowest informational level and the broader applications that he looks forward to. It is not a new concept that higher LoAs subsume aspects of semantic information. What LIR does is to place this concept, and thus the "superconcept" of information in a naturalized physical, metaphysical and logical context. Information is thus both a means to model the world and part of the world that is modeled and LIR describes the relation between them.

Comparing this view with that of Wu Kun, we see that in his Section on Complexity and the Program of Information Science, Wu calls for a research program that takes into account both the relative independence and mutual dependence of the elements of information systems, that is, all systems. As does LIR, Wu insists on the need for the *dialectic integration* of antagonistic relations such as those between reductionism and holism, determinism and non- or indeterminism, internal and external feedback, parts of networks and wholes, finally matter-energy and information. Where I and Wu differ is perhaps only in the emphasis to be assigned to the degree of reality or appearance of internal and external randomness and their interaction. As Wu states, however, it is ultimately the multi-level complex information feedback loops between a system and the environment at the thermodynamic level that determine its stability or survival.

2.1.1 Double Evolution of Information. The "Informosome"

The important conclusion for a theory and philosophy of information is derived from the concept, expressed in the Principle of Dynamic Opposition (PDO), that future evolutionary paths are available in the residual potentialities of the material elements and that all entities are a unity of actuality and potentiality (LIR) or direct and indirect existence (BTPI). LIR grounds the non-total separability of internal and external properties and their complex interactions, and the totality of their evolutionary movements are, in my view what constitutes information. Depending on the level of reality involved, the information will include varying proportions of the kinds previously defined (Section 3.2) (in-itself, for-itself and social). Wu has designated this complex as an "informosome". This term is currently in use in biology [Allaby, 1998] to refer to mechanisms of protein transfer in the cell, but this process should indeed be understood as informational in the broad sense of this paper. This is a further consequence of my view that both material processes and their informational components evolve together. (The neologism of "informosome" is similar to the new term "exposome", also from the field of biology [Lopes and Silk, 2010]. The term exposome refers to the totality of environmental exposures of an individual from conception onwards, and has been proposed to be a critical entity for disease etiology. I note that, interestingly, that like the informosome, the exposome is constituted by a totality of *information*. It *is* an informosome.)

It is a basic principle of the interaction between subject and object, in their standard definition as different entities, that there is no direct contact between them at all times or any times. Logic in Reality postulates that, for example in the case of two people, they are *not totally* separate, but that each has internalized and thus shares part of the other's mentality or personality. Such a process, as Wu correctly points out, must have taken place *via* a series of intermediate steps ("intermediaries"), each of which should be considered from an informational standpoint, as an informational process. This concept characterizes the general processes of human cognitive activities as informational activities.

2.2 Semiotic Approaches

The difficulties of providing a principled description of the obvious non-physical properties of information has tended to favor approaches based on the extremely comprehensive categorial view of the world proposed by C. S. Peirce. Semiotic approaches are popular because they provide a way of discussing the intangible properties that seem to accompany the transfer of information and meaning.

At first sight, the semiotic approach to information might appear to capture its multiple facets, ordering them into the functional categories proposed by C. S. Peirce. Brier has provided a complete current interpretation of Peirce in relation to information in his *Cybersemiotics* [Brier, 2008]. However, I consider Peirce's theory insufficiently dynamic because there is no energy that can be assigned to his triadic relations that would give them a basis in reality (physics). I see the same problem with Peirce's categories as with the Hegelian triad of thesis, antithesis and synthesis: there is no deductive basis for the movement from one term to the other or a description of any physical interaction between them. If the argument is made that nothing of the sort is required, my response is that is exactly the problem – the terms are not physically grounded and hence have limited explanatory value other than as a heuristic device for keeping track of the entities involved in biological processes; its use should not make one neglect the real properties of the system.

The Peircean semiotic concept of information has been summarized by [Quieroz *et al.*, 2008] (QEE) as a "triadic dependent" process where a form is communicated from an Object to an Interpretant through the mediation of a Sign. My critique of this approach is that as stated by Peirce himself, it is derived from a *formal* science of signs that provides an *analytical* framework. Thus the QEE approach to information as process is constrained by the abstract characteristics of the Peircean categories, that is, their abstraction from dynamic aspects of real physical phenomena.

In contrast to QEE, I derive the triadic characteristics of information from the LIR view of the contradictorial evolution of all real processes, providing the physical basis for the QEE differentiation of potential and effective (actual) semiosis and consequent definition of potential and effective *information* as well. In LIR, information is a complex of processual interactions with both binary (dyadic) and ternary (triadic) properties, all of which can be predominantly actualized (effective) or potentialized (not effective) at any time. This would seem preferable to the nebulous concept of a Sign as a Medium for communication of Form.

The essentially static linguistic definition of Form in terms of "conditional propositions" states that certain things would happen under certain circumstances. Strikingly, as quoted by QEE, Peirce said that "*Form can also be defined as potentiality ('real potential': EP 2.388)* (emphasis mine). In LIR, structure and form are also physical processes, including the physical processes of their conceptualizations. Form is characterized not as 'potential' only, but as a process whose elements are both actual and potential at the same time.

In summary, in my view, semiotic approaches to information have gone to an anti-realist, epistemological extreme, ignoring relevant physical characteristics of information that are implied in Wu's discussion of the relation of energy and information. One of the major points of concurrence between the BTPI and LIR, as first seen at the 2010 Beijing Conference are in fact the central position given to energy in its actual and potential aspects. In fact, it is not surprising, in Wu's realistic ontological and interactive approach to information, the *absence* of references to semiotics.

There is, the above notwithstanding, a convergence of intention between Wu and Brier in that both work toward creation of a broad philosophy of information and cognitive and communication science in which different

approaches can be seen not as mutually exclusive, but rather as mutually complementary in accepting an ontology where reality does have structures and processes. I note that Brier, as do Wu and I also calls attention to the transdisciplinary character of information and communication science. LIR extends the foundations of information processes, like other physical phenomena, however, back to physics and provides a basis for discussion of the contradictorial patterns of evolutions of complex entities, without recourse to Peircean speculative categories.

The basis is in hand, therefore, for a new form of theory of information in which epistemological and semiotic considerations are supplemented by the natural ontological concepts of Wu, as well as by the causal-operational concepts of Burgin discussed below (see Section 2.4).

2.3 Unified Information Theory

Recognition of the problems of classes of prior theories of information has been well summarized by Hofkirchner, most recently in his analysis of the requirements of a potential Unified Information Theory (UIT). I see in this work an important emphasis on the importance of a proper hermeneutic process rather than on some chimerical "final and complete" theory.

2.3.1 Toward a Unified Theory of Information

I note first that the scheme of principled distinctions proposed by Wu has a relationship to and a place in the conceptual approaches that Hofkirchner has recently listed to a Unified Theory of Information (UTI). Hofkirchner [Hofkirchner, 2009] among others has argued for the desirability of a UTI that would encompass the different manifestations of information processes. Such a UTI should be capable of balancing the apparently contradictory properties of information - physical and non-physical, universal and particular - without reduction. Its underlying principle should be "as abstract as necessary but as concrete as possible at the same time." Hofkirchner considers information as a "superconcept", which includes a group of overlapping concepts such as message, signal, *etc*. as they apply to communication, cognition and cooperation between human and non-human organisms. Hofkirchner asks how matter and idea, mind, information, *etc*. can be grasped as complements and with them information as a thing (a structure, a flow) or as a human construction. Hofkirchner gives a dialectical answer to the implied division between subject and object, suggesting that mind, and with it information, is of a different 'materiality' than 'non-emergent' states of matter.

His own approach to a Unified Theory of Information (UTI) is to eliminate the absolute and in my view artificial separation between critical concepts of information in favor of a dialectical relationship similar to the ancient intuition of 'unity-in-diversity'. Specifically, his "UTI seeks a concrete-universal concept of information rather than an abstract one". Hofkirchner wishes to avoid reliance on a "formal-logical figure of necessary and sufficient conditions" and use a way of thinking that integrates as well as differentiates the particular and universal", with which LIR agrees.

From the LIR standpoint, mind and information can be seen as "complements" if one sees them as processes. Structure, flow and "human processing activity" all follow the same real, physical dialectics. If matter and information are differentiated in a "common genus", for LIR*, that genus is simply energy, and both follow its logical patterns of evolution*, avoiding the problems of the term "different materiality". Logic in Reality is, also, a

logic of emergence or "emergent materialism". In this view, information is, *pace* Wiener, an energetic phenomenon that instantiates real contradictions.

Both Wu and I consider that the "opposites" or contradictions in information are not captured by the classical concept of a classical, static "unity of opposites", but by the dialectical interaction of the opposites as classified above. The Wu classification is thus the critical *first step* in the characterization of the complex phenomenon of information.

Hofkirchner's approach to a Unified Theory of Information (UTI) is to eliminate the absolute and in my view artificial separation between critical concepts of information in favor of a dialectical relationship similar to the ancient intuition of 'unity-in-diversity'. Specifically, his "UTI seeks a concrete-universal concept of information rather than an abstract one".

Hofkirchner's information "superconcept" includes a group of overlapping concepts such as message, signal, *etc*. as they apply to communication, cognition and cooperation between human and non-human organisms. Hofkirchner asks how matter and idea, mind, information, *etc*. can be grasped as complements and with them information as a thing (a structure, a flow) or as a human construction. Hofkirchner gives a dialectical answer to the implied division between subject and object, suggesting that mind, and with it information, is of a different 'materiality' than 'non-emergent' states of matter.

From the standpoint of both the BTPI and LIR, mind and information can be seen as "complements" if ones sees them as processes. Structure, flow and "human processing activity" all follow the same real, physical dialectics. If matter and information are differentiated in a "common genus", for LIR*, that genus is simply energy, and both follow its logical patterns of evolution*, avoiding the problems of the term "different materiality". Logic in Reality is, also, a logic of emergence or "emergent materialism". In this view, information is, *pace* Wiener, an energetic phenomenon that instantiates real contradictions.

Hofkirchner's UIT is, appropriately, itself very much work-in-progress, and is in fact the title of a research project at his Institute. Nevertheless, its focus as a necessity for the development of an ethics for the emerging Information Society [Brenner, 2009] brings it close in spirit to the work of Wu.

2.4 Information as a Natural and Social Operator

The approach of Mark Burgin to a General Theory of Information, also developed over the last twenty years, has several major components. In 2010, Mark Burgin described a new systematization approach, which he called a General Theory of Information GTI [Burgin, 2010], based on several ontological and axiological principles for the definition and use of different kinds of measurement and evaluation of information. Among the information measures of interest for this paper are his theoretical abstract and realist measures, especially the latter, of which quality is one example. In this view, there can be no universal measure of information, since information has not only properties but functions, and his GTI treats information from the functional, dynamic perspective. Burgin continues his useful classification by reference to semantic, qualitative, algorithmic, pragmatic, social, utility, economic and dynamic theories of information, all of which are shown to be sub-theories of GTI.

In another paper in this Journal, Burgin and I develop a further conception of information as a natural and/or social operator. What is of interest from the perspective of the present paper is that Burgin also emphasizes the primary role of energy in defining information.

2.4.1 Energy as Information

For Burgin, energy is an example of information in a broad sense, and thus the most basic natural operator. The three-dimensional energetic world is a flow of information and structural and kinetic information is an intrinsic component of the universe, independently of whether any form of intelligence can perceive it or not. Both Burgin and I therefore reject even more radical points of view such as expressed by Wheeler [Wheeler, 1990], who claimed that every item of the physical world is information-theoretic in origin. In this view, all such information is composed of a multitude of information operators, *e.g.*, information in an instruction is an information operator [Burgin and Brenner, 2010], however, point out that views such as those of Wheeler can lead to misunderstandings about the correct ontological relation of priority between information and matter-energy. It is the latter that is primitive, and failure to recognize this has often led to excessive idealizations of the concept of information.

2.4.2 Information as a Social Operator

However, information acts not only in nature but also in society, becoming (in the sense of Lupasco [Lupasco, 1973] a social operator, the role of which is essentially important in the modern Information Society.

The most common notion of an operator in society is, nevertheless, of a human being having control over the flows and use of knowledge and information [Castells 2000]. The operator approach to information as having causal efficacy in the society is somewhat different. First of all, I am not concerned only with the pragmatic consequences of the operation of quantitative informing about certain facts, which includes knowing that certain sentences are true in semantic theories of information or how to achieve simple results.

As pointed out by Leydesdorff [Leydesdorff, 2009], interactions between and among human beings are by definition reflexive, and can be considered as the basic operation of a social system. In turn, interaction between human beings usually is or includes communication, which is an exchange of information. The double contingency in which two individuals entertain (anticipate) expectations provides the basis for the formation of groups. Logic in Reality establishes the logical basis for the reciprocity of the interaction between 'self' and 'other', interactions that have been studied by Wu.

2.4.3 Interactions

Let us now explore further the central role of interactions in Wu's reasoning about information. His view of information as involving interactive processes is not new as such. What in my opinion needs to be emphasized is the way in which internal and external factors must be understood. These include the multi-level nature and characteristics of the actual and potential (virtual) interactions that mediate the construction and transformation of information in which they (the interactions) evolve logically and dialectically.

Wu Kun's focus on the causes of awareness and the intentional structure of human activities is neither trivial nor arbitrary. His "theory of interactions" has the simplicity of a single initial dimension and a single "polarization". (Polarization in Wu's sense here means a vectorial characteristic of complex phenomena toward higher complexity. It has the same intention as the movements toward non-contradiction or contradiction in the theory of Lupasco, within the overall energy gradient in the universe). Human knowledge is the most complex emergent phenomenon, the highest product of the evolution of the universe. The interpretation of the causes of the existence of human knowledge requires a coherent construction of the complex configuration space which includes (at least) the following new multi-dimensional entities: that of the interaction between a subject and a

target object; the subject's physiological structure, the structure of the understanding subject, the material components of social, that is, multi-subject practice, and that of their historical development.

For Wu, the interactions involved between internal cognitive and other structures (subject world) and the external object world take place in a chain of "step-by-step informational transformation, selection, construction and virtualization. The interactions are the links in the chains, each providing output to the next. However, Wu's key formulation is that "for a chain of interaction starting from the object, the information state constructed in the subject *will still retain some correspondence with the properties of the object* (emphasis mine)". The concept in Logic of Reality of processes evolving *via* chains of chains of chains, *etc.* of real implications explains, in my joint view, the nature of that correspondence or "similarity", namely, as the properties of the "object" potentialized in the "subject" and *vice versa*, as the chain evolves. This is what Wu refers to as the "match" in the cycling or recycling of information between subjective model and its objective "target" in nature.

In contemporary society, the importance of information is much higher and continues to grow rapidly. The application of information is one of the key sources of growth in the global economy, acting as both a social and economic operator. For a broad discussion of the emerging information-based Economy, I refer the reader to [Leydesdorff, 2006]. One of the consequences of information being a social operator in an economic environment is that information has become the key strategic asset for the 21st century. Every organization must invest in developing the best strategy for identifying, developing and applying the information assets – networks, processes and methods - it needs to succeed. Information operates (the behavior of) people, social organizations and social institutions and to stay competitive, companies must implement training and continual development programs to help maintain an efficient level of information resources utilization.

A peculiarity of information as an operator is that it can be (and usually is) an operator and an operand at the same time. Indeed, throughout history, people have always tried to manage their information as best they could, introducing new ideas, new methods, new processes and new strategies that enabled separate individuals, social groups and society as whole to better think and work. However, in the Information Society, individuals, teams, organizations, and between organizations have to find new ways to efficiently manage information. Researchers started to search radical and fundamentally new ways to accelerate information processes, such as identifying, creating, storing, sharing and applying information. In all these processes, information becomes an important actor, assuming the role of an operator and displaying the feature of self-operation. In essence, information as a natural operator is very important for self-regulation of various social systems.

The "language" of operators with regard to information is entirely compatible with the BTPI of Wu Kun and Logic in Reality as outlined in this paper. I note that these are broad concepts which also apply to Wu's Existential Field. It is not sufficient to say that information is in everything or everything is information without specifying why and how these statements describe reality and what the logical (in LIR terms) consequences are.

3 THE METAPHILOSOPHY OF WU KUN (1): DEFINITION AND THEORY

3.1 On Metaphilosophy

The subject of metaphilosophy is a somewhat unusual one for a discussion focused on science and technology. On closer inspection, as Wu Kun has observed in the case of information, a metaphilosophical approach is

essential to avoiding unnecessary and misleading distinctions between disciplines and their informational aspects.

A standard definition of the term metaphilosophy, one that is apparently simple and non-controversial, is a statement or set of statements about philosophy. For example, the *Journal of Metaphilosophy* lists the following definitions in its Aims and Scope: the foundation, scope, function and direction of philosophy, the following: the interrelations among schools or fields of philosophy: aspects of philosophical systems; the relation of philosophy to other disciplines and the justification (presumably by some form of truth-preservation) of philosophical methods and arguments. The concept that is lacking in this otherwise most desirable set of objectives, and also in the literature in general, is that of structure or function*ing*, in other words, the 'how' rather than the 'what' of philosophical argument.

I first note that a discussion of metaphilosophy requires a definition of both philosophy and the task of philosophy as well. In that of Sellars [Rosenberg, 2006], "the aim of philosophy is to understand how things in the broadest possible sense of the term hang together in the broadest possible sense of the term". Sellars contrasted the understanding of the world that is possible for perceiving human beings, considered as free, rational agents, capable of self-perception ("manifest images") and the entities present in the macro- and micro-physical world that is understood through science ("scientific images"). His intent was ultimately the merging of these two conceptions, one self-referential and one not, in a synoptic vision or synthesis of "persons-in-the-world".

Both Logic in Reality and the Basic Theory of the Philosophy of Information provide a basis for understanding both the metaphysical and epistemological dynamics of existence, that is, from where the properties of things come from that enable both them and the concepts of them to contrast, conflict and ultimately "hang together". In modern philosophy, one is struck by the frequent admission that not only are two conceptual descriptions, such as those alluded to above that are apparently irredeemably opposed, there is no basis available for preferring one to another. My answer to the problem is to recognize its source in the failure to describe correctly the relationship between the positions, objects, entities, and above all processes that constitute the real world including theories-in-contradiction.

The recursive relation between philosophy and metaphilosophy instantiates this principle: 1) no aspect of one is totally devoid of aspects of the other, and any absolute division into first- and second-order problems is arbitrary; 2) the question of an infinite regress of 'philosophies' does not arise. In the epistemology of LIR, iteration, in this case of *real* relations, stops after two or three stages because no new information is added by subsequent stages. The elements of knowledge and the knowledge of that knowledge are in a contradictorial relationship that exhausts the available mental configuration space. One can *imagine* an infinite regress as a process that does not stop, but in reality one stops it, or it stops itself.

A theory of metaphilosophy that talks only in terms of categorial separation or distinction between elements, disciplines or methodologies in philosophy is that of Toulmin [Toulmin, 1976]. In my view, any such theory has a certain limited domain of validity, in which it is more or less adequate or appropriate to the philosophy in question. The broader role of metaphilosophy for information and by implication for all other disciplines has been given by Wu: "Now, my research is still basically limited to elucidate the general basic theory of philosophy of information from the angle of a metaphilosophy. At such a level, there is a lot of work we should do to define the philosophical essence of information, the philosophical shape and form of information; the nature of the different levels of information; a philosophical measure of information; the relationship between information and various prior definitions of its scope; information ontology, information epistemology, information methodology; the evolution of

the informational world; information in material and social evolution; informational sociology and psychology; informational esthetics: an informational theory of value; there are still have very abundant and a large number of branch issues in the each area field of that listed above [Wu, 1989]."

My view thus offers a novel dialectic perspective on philosophy, metaphilosophy and their recursive relation. It naturalizes this relation, eliminating any implied circularity, since it does not require the total independence of premises and conclusion of standard logics. Starting from the fundamental properties of matter-energy, my theory permits a new approach to critical issues in both philosophy and science that is both logical and metaphilosophical.

As indicated in the Introduction, Wu's metaphilosophical view of information is not directed toward the codification of *a* Metaphilosophy of Information as yet another static discipline or body of knowledge. It is rather an attitude toward the position of an adequate Philosophy of Information as encompassing a critical component of all disciplines, beyond the scientific content specific to them. In my approach, metaphilosophy is not something 'more abstract' than philosophy and it must be able to deal with the essential aspects of all disciplines and their theories. As it exemplifies the suggested dynamics of Logic in Reality, it resembles real physical processes, and provides insight into the real interactions in the real world that are my ultimate concern.

3.2 Informational Thinking and the Metaphilosophy of Information

It is perhaps a first indication of an approaching maturity of the field of information that, based on the contribution of Wu Kun, one can begin to talk about a metaphilosophy of (a theory of) information that can accept the various approaches outlined in the previous Section without conflation. One of the consequences, however, is that the comprehensive nature of such a metaphilosophy, within the transdisciplinary paradigm defined in Section 1, establishes the role of those involved as a socio-political role, involving them in the social and ethical aspects of the informational components of reality.

The Metaphilosophy of Information, then, requires attention to the informational aspects of complex processes as a methodological necessity, in a process that Wu calls Informational Thinking. Informational Thinking *(IT)*, as conceived of by Wu, refers to a way of grasping and describing the essential characteristics and attributes of things by reference to the structure and dynamics of the information involved in their evolution, from their historical origins to future possibilities and probabilities. This strategy involves something like a Husserlian bracketing of the details of any complex process to consider the ways in which information functions in its dynamics, as well as the dialectical relations between its logical elements as proposed by LIR. However, the difference between Wu Kun's theory and that of Husserl is obvious: the purpose of Wu's original Philosophy of Information is to clarify the nature of the dual existence and dual evolution of material and information in the objective world, starting from the logic of the existence and dynamics of the natural human self. The phenomenology of Wu, unlike that of Husserl, does not have to be "naturalized", that is, brought into the domain of natural science[1]. It is already there. Wu then discloses directly the mechanisms of the processes involved in an

[1]The naturalization of Husserlian phenomenology was the subject of a major 1999 study: *Naturalizing Phenomenology. Issues in Contemporary Phenomenology and Cognitive Science*. Eds. Jean Petitot et al. Stanford University Press, Stanford. Wu's approach eliminates the arduous task of finding natural equivalents for Husserl's transcendental intuitions.

individual's understanding at the level of the integrated object and subject, with internal and external interactions providing the necessary multi-level objective and subjective mediation.

In this sense, all of the cognitive issues addressed by Wu, especially informational values, valence and social evolution, have implied the use of Informational Thinking for their analysis. *IT* requires the abandonment of thinking in absolute material terms in traditional material while retaining its commonsense foundations. *IT* is basically a methodological concept that, *via* the definitions of carriers and codes of information, enables *inferences* to be made about the historical and potential or probable future states of an information system. *IT* dialectically unifies energy factors and informational factors, determinism and indeterminism, internal and external feedback processes, independence (autonomy) and interdependence. LIR provides the additional *logical* structure for the dialectic interpretation of such a unified approach, based as I repeat on the impossibility of any total logical or physical separation between these dualities. In fact, Informational Thinking is the Metaphilosophy of Information in other terms.

To the extent that Informational Thinking requires the consideration of all the philosophical and scientific facets of information, I believe that we are close to a new scientific (and logical) paradigm where Informational Thinking, as opposed to thinking in terms of entities, results in new interpretations of, among other things, traditional disciplines and their theories. Above all, I see the (meta-) philosophy and (meta-) logic of information outlined here as a contribution to the naturalization of a process view of information as a whole. In other words, by seeing the relations between the changes in values that take place in human informational activities and the forms of society, a more profound understanding of information is possible that could be a contribution to overall progress and sustainable development of human civilization. Information Science, Metaphilosophy, Metalogic and Thinking may thus facilitate what Wu calls for, namely, a change in the commitment to and the interpretation of the dynamic oppositions in all complex natural processes in informational terms.

Through the study of information as one of the most basic features of existence, and the formalization of informational activities, the Metaphilosophy of Information of Wu can and should change the way basic philosophical – metaphysical, epistemological and ontological – issues are discussed. The Philosophy of Information supported by the new extension of logic to the same processes that it discusses, could be a "comprehensive revolution in philosophy", as LIR has been called "an important event in the current revolution in non-classical logics"[1].

As a final comment, I note the almost total absence of serious literature on the metaphilosophy of information. One exception is an article by Sebastian Sequoiah-Grayson, a collaborator of Floridi, entitled "The Metaphilosophy of Information [Sequoiah-Grayson, 2007]. The article is essentially in support of Floridi's concept of strongly semantic information, and in fact indicates only two items of content of a "metaphilosophy of information": 1) that it should include "Shannon's Premonition" that there will always be a multiplicity of theories of information and 2) explications of the pre-theoretical notion of information are to be judged by their usefulness. These ideas are more or less acceptable in the context of this paper, but they do not say very much. I have found no other serious references to the metaphilosophy of information. Wu Kun, through the substantial exposition outlined briefly in this paper, should be considered as the major pioneer in this field.

[1] He, Hua-Can. 2008. Personal communication.

3.3 The Informational Stance

I believe that the approaches that I have proposed in this paper describe primarily an attitude or stance, which I have termed the *Informational Stance*, a philosophical position and attitude that is most appropriate for, and above all not separated nor isolated from, the emerging science and philosophy of information itself. The Informational Stance [Saguillo, 2009] is an attitude that requires attention to the informational aspects of complex processes as a methodological necessity.

The concept of *stance* in recent philosophy was laid out by Bas van Fraassen in relation to his constructive empiricism. I will not reproduce here the debate about mathematical structural realism and scientific discovery to which it has led, but I can say the following: In his *The Empirical Stance* [van Fraassen, 2002] van Fraassen presented a new view of philosophical positions as 'stances' that involve judgments, aims and commitments in addition to the attitudes toward propositions (beliefs, hopes and knowledge) on which standard epistemology has functioned. However, van Frassen, in accord with his anti-realist conception of science, rejected any metaphysics of phenomena that has now been shown to be necessary. In the same Special Issue of *Synthèse* on Stance and Rationality, Ladyman [Ladyman, 2010] proposes a new "scientistic" stance, naturalized within his relational framework and suggests that science in fact depends for its success on dialectic between empiricism and materialism. The debate about materialism has been obscured by skeptic attacks that it requires positing of ontological entities for which there is no evidence. Logic in Reality, however, supports an "enhanced" form of materialism (scientific structural realism) as a basis for a scientistic stance that is a better logical basis for the dialectical interaction between empiricism and materialism.

The Informational Stance that I describe eliminates the necessity for even the points of empiricism that Ladyman would like to retain in his scientism, namely, "disdain for demands for explanation" and "the hostility to non-naturalistic metaphysics". My theory supports his idea that "we should have a metaphysical picture of the world to discipline scientific methodology, and science and education policy", and I note, as originally formulated by Wu, the non-separability of metaphysics, epistemology, value theory and social issues.

Summarizing, I view a stance as an interactive process, in which the human individual or group is engaged morally and politically, as well as being an epistemic observer in the standard philosophical sense. In fact, consistent with my overall logical approach, it is not necessary to make absolute separations between informational stance, thinking, philosophy and the ethical dimension. It is rather a question of alternating focus, and I place mine on the latter in the next and final Section.

3.4 The Ethical Dimension. Information and the Democratic Society

Among the major authors who have pioneered the dialogue on the ethical aspects of information I note again Luciano Floridi [Floridi, 2008] and Rafael Capurro [Capurro, 2008] in addition to Wu Kun.

Floridi was one of the first to define an Information Ethics (IE) that focuses on entities as informational objects, constituted by information at a fundamental level. As I discussed, [Brenner, 2010a], the most important consequence of this strategy that it generalizes the concept of moral agents, as IE is ontologically committed to an informational modeling of *being* as the whole informational field. The result is that no aspect of reality is extraneous to IE and the whole environment is taken into consideration.

In the "environmental" approach, IE moves from an epistemological conception to one which is typically ontological. Informational systems as such, rather than just living systems in general, are raised to the role of

agents and patients of any action, with environmental processes, changes and interactions are equally described informationally.

LIR is compatible with the indicated information view. The ontological feature of non-separability suggests strongly that there is not and cannot be any difference in the fundamental value or worth in the common component of all entities participating in existence, whose evolution and change involves the same logical principles operating on the same physical substrates. For LIR, the respect due to informational entities is a logical consequence of my general dialectic relationships to "external" objects, and to ourselves as patients as well as agents who have internalized these relationships.

I define Ethical Information (EI) as a sub-domain of the infosphere in which the most significant property of the information that is transferred is not its propositional truth *per se*, but its intentional content and corresponding impact on the receiver. Ethical Information is thus much less concerned by the physical, technological context or substrate, (*e.g.*, cyberspace) in which the behavior occurs as with the human agents involved. The consequence is that EI may apply strictly to human individual agents and groups and but not to artificial agents. The ethical value assigned in IE to artificial agents is obviously not the *same* as to living beings, and the difference is worth emphasizing to avoid some ill-founded confusion.

The clarification that Logic in Reality brings to the controversy, as indicated briefly in Section 3.4 above, is to relax the requirement that individuals and groups are *a priori* totally separate entities, and allow each to share part of the others properties, including intention. The shared properties are not 100% actual or actualized at one time; they can be present as potentials of which individuals are more or less vaguely conscious. As Floridi has clearly demonstrated, information can be among those shared properties.

Information exchanges thus take place in a psychological (or metapsychological) context which will largely determine both their ethical purport and its effect for and on the sender and receiver respectively. Like Floridi's Information Ethics, Ethical Information subsumes the simpler concepts if information described by Floridi in connection with earlier "microethical" theories of Information Ethics, but its primary reference is to complex informational process entities involving interactions at and *between* higher Levels of Abstraction, such as, for example, environmental programs and the data and theories supporting those programs.

Ethical Information in process terms is for me a reality in a physical space (as opposed to a data space), with an intentional "valence", positive and negative, in the morally valued interaction between producer and receiver. LIR is neither topic-neutral nor context independent, and can support an ethics involving apparently contradictory perspectives (*e.g.*, internalist and externalist, [Finlay and Schroeder, 2008], and assigns value to negative as well as positive information. Logan [Logan, 2010] has also pointed out the lack of attention paid to the qualitative as opposed to the quantitative aspects of information, that is, the need to incorporate a functional notion of meaning.

The result is that from quite a different starting point, Wu and I arrive at a key concept for a macroethics of information. We as human individuals share properties with other humans and other extant entities, living and non-living, constituted by the same substrates organized into the corresponding systems and process entities by the same principles and by their informational content. Both are accordingly deserving of respect and care.

In 1997, Wu Kun elaborated "An Outline of General Philosophy of Value; the philosophy of value explained in terms of natural entities". He proposed the application of a system of natural values to both matter and information, seeing value in all things (matter, information, including the subjective form of information – mental phenomena) that were a resultant of the interaction between internal and external processes, As Floridi did some

years later, Wu associates the material value and the informational value that emerge in the interactions. Natural value is "higher" than human value not in a moral sense, but in an the sense of being ontologically prior.

Introna [Introna, 2005] has made a useful phenomenological categorization of the ethical implications of information technology. They are similar to those of Wu in focusing on the operative interactions in which technology and society co-constitute or co-construct each other.

3.4.1 Information in Society and the Network Approach

Starting in the 1980's, Wu Kun studied social phenomena from the perspective of information activities, providing an information theory dealing with the nature of social information and an informational scale of social evolution. In the 1990's, Wu extended his research in this field to information production, the information economy and the information society, in a series of related papers and books. In Wu's conception, the active grasping, use, development, creation and implementation of information is the essence of human social behavior. The level of development, creation and use of information that a society achieves is a measure of its evolution. The development of different forms of human civilization takes place *via* different methods of information creation, processing and dissemination. Unlike matter-energy, which is conserved and not "creatable", human beings can only create information. Thus human production and productivity in essence can only be the production of information and corresponding modes of human information processing. In this process, a network development of modes for the creation and dissemination of information is accompanied by the resorption of the hegemony of centralized national control systems. This process is a "technical premise" for establishment of a new and democratic network system. Wu thus attaches substantial importance to a network concept of the structure of society. A comparison with that of Castells seems appropriate.

The major work of Castells on economic and political applications of new information and communication technologies in the emerging information society and knowledge-based economy, first published in 1993, [Castells, 2000], his *The Information Age: Economy, Society and Culture* has proven extremely prescient. He saw society as a complex system of networks that are a consequence of the new information and communication technologies. His views have been of interest from the LIR perspective because of their reference to a "logic" of the network society and of its dynamics. Castells' network model of society as a "space of flows" can be analyzed from the LIR logical standpoint, as well as more standard sociological models, *e.g.* Leydesdorff's "triple helix" [Leydesdorff, 2006]. The LIR logical approach is applied to an analysis of the properties of the networks and their nodes, as well as to the segments of the society that are disfavored or excluded completely.

For Wu, such networks can be "the liberator of knowledge, liberator of information, liberator of information creation and dissemination mode, the liberator of the social power, liberator of human relationships, liberator of human mode of thinking, liberator of human values, the liberators of human life-styles and behavioral mode, in the final analysis is the man himself liberator, human social liberator." Wu sees the decline of central, national modes of information processing and the popular development leading to a new democratic system consistent with the new trend. This new democratic system will have more tolerance and understanding, of minority rights, interests, values, and different views on the rights, interests and values of both the individual and the group will be more fully respected, perform and satisfaction. He is hopeful that the spread and development of network information processing, creation and transmission modes, allowing a multiplicity of human values, are the informational basis for a more just future society. In all of these considerations, however, I follow Tavani

[Tavani, 2007] who believes nothing has "happened" to change the core human values of life, liberty and justice, but any normative theory of the evolving technology and information based society still requires a correspondingly current view of morality and ethics. [Franssen *et al.*, 2010] point out the importance of ethics within the Philosophy of Technology, but standard logic does not address this major new field.

Magnani [Magnani, 2007] also discusses the changes that will be required in the application of ethical theory. He calls for a revitalization of research in ethics to achieve a "long-range ethics of responsibility", and deserves credit for accepting, analyzing and trying to prepare for the consequence of technological developments leading to what he sees as a *fait accompli.* He makes the rather unusual argument that since the current tendency is to ascribe high value to things one should value people as things, inversing the Kantian maxim of the necessity to treat people as ends. Magnani suggests that the primary impact of technology is effectively to create a man-machine hybrid. This entity, however, has the same moral obligations, defined as Kantian duties, as humans have always had, but now primarily related to knowledge, far more easily accessible than in Kant's day. People have a right and duty *to* knowledge as such and as a basis for action.

Human interests should be at the heart of any proposals for change in the society defined today by the evolution of its information processing modes in the scientific, economic and social domains. However, any theory or model of such changes cannot ignore the fundamental embodiment of contrary, anti-social and anti-civilizational forces in the society that make the "common struggle" for implementation of the human values discussed above a struggle indeed.

Thus Wu calls for a "new democratic system" that would permit maximization of the benefits from the new information technologies. As noted above, an "ideal" Information Society would require, Wu suggests, the emergence of a diversified, non-authoritarian network involving a modern form of the atrophy of centralized natural systems. In any event, proper attention to the informational aspects of any politico-economic model is necessary, and would be the consequence of the Informational Thinking and Informational Stance described above.

4 THE METAPHILOSOPHY OF WU KUN (2): INFORMATION SCIENCE, THE UNIFICATION OF KNOWLEDGE AND A NEW CRITIQUE

Elaborating further on the hermeneutics of information science, Wu Kun conceives its advent in essence as a scientific paradigm shift, involving a total transformation and reform of traditional science. In this new paradigm, a number of things take place:

- The establishment of a Unified Information Theory (UIT) is not only possible, but inevitable.
- There are major consequences for the unification of knowledge.
- A new critique of philosophy can be formulated

Regarding the first point, Wu believes that the establishment of a UIT would require answering the core question of the essence of information. According to Wu, there is a tendency in modern western theory to try to avoid definitions, but this tendency is only suitable for the deconstruction of existing scientific concepts and theories, but not for building new ones. For example, a UIT could involve a new process of theory construction.

The concept of change of scientific paradigm suggested by Wu is similar to that proposed by Cao for the ontology of the development of science. Both allow a certain ontological continuity accompanying a conceptual revolution [Cao, 1997]. This ontological *synthesis* is a dialectical picture of growth and progress in science that reconciles

essential continuity with discontinuous appearance in the history of science, a process that, again, is a logical one in LIR.

From the systems point of view, for all the concepts involved in the establishment of a theory, it should be possible to group them in a way that would enable a firm and clear interpretation. Otherwise, these concepts and theories can not be properly understood.

In Wu's conception, the nature of information is such that it is involved in the constitution of the basic areas of existence of the world, revealing their essence and most general, universal characteristics. Such universality can only be studied at the highest level of general philosophy. Because of this, a UIT can be expected to have the structure and nature of a general philosophical theory. Only from the vantage point of the philosophy of information can one perceive the essence of information that is required for building a Unified Information Theory.

Regarding the consequences for the academic disciplines, in a recently completed thesis, Wu Kun suggested that studies in philosophy, ontology, epistemology, methodology, language theory, practice theory, value theory, existentialism and so on should be unified, leading to an eventual unification of knowledge. Even more importantly, perhaps, he wrote that "innovation in philosophical theory does not simply lie in its areas of concern or as related to a range of subjects, but more in the inherent or implied domains: relevance theory in the basic areas; points of view; distinguishing new from old theoretical content and so on".

In fact, in my opinion, based on his Philosophy and Metaphilosophy of Information, Wu is proposing a major new critique of the foundations of philosophy! In this view, up till now all philosophical theory, all schools of philosophy have proposed theories that attempt to understand the scope of the general field of existence as a foundation for the understanding of the relationships between people and objects (or the world). This mode of understanding focused mainly around the relationships between matter and "spirit", or the relationship between subject and object. The difference between different schools and theories of philosophy lies in how these relationships or aspects of them are rejected or eliminated, or which should be emphasized or made dominant. The most extreme theories take the spirit or elements and modes of certain activities to a position of absolute supremacy, absolute, exclusive, one-sided and oversimplified. (This tendency was also described by Lupasco as a drive toward identity and certainty, for which he saw the fundamental psychological basis in the non-identity and non-certainty of human existence.) In view of this, despite the development of a humanistic philosophical theory in some research areas in the direction of a conversion of research toward new concerns, on the foundation of existence theory and epistemology no fundamental change has ever been achieved. One is left with the same fundamental commitments and concrete interpretations of existence based on the binary oppositions between matter and spirit, between subject and object and so on. Based on this analysis, so far, philosophy has never accepted any truly meaningful change in its fundamental approach.

On the other hand, Wu Kun takes the concept of information as the most fundamental one for philosophy, leading as we have seen to a novel model for the partition of the existence field that changes the way concrete expressions about basic philosophical issues can be made. The result is that the new Philosophy of Information enables a "conversion" of the fundamental bases of philosophy that can lead to further fundamental and desirable universal changes in the philosophy of man [Wu, 2009].

CONCLUSIONS AND OUTLOOK

This paper has suggested the importance of several partly informal theories as providing an essential new perspective for progress toward a General Information Theory. The outline that I have provided here of these theories is both the minimum necessary for some understanding of them and the maximum possible given the limitations of space. Logic in Reality (LIR) provides a new logical or metalogical, transdisciplinary framework for the discussion of philosophy in relation to information, and I have come to the conclusion that the concomitant use of LIR, together with the Basic Theory of the Philosophy of Information (BTPI) to describe information and its operation in society is unavoidable. Both the BTPI and LIR are grounded in physics, and they avoid the reductionism inherent in purely linguistic, semantic or semiotic theories of information that reflect principles of standard bivalent logics.

My major conclusion is that the BTPI of Wu, his new informational view of the need for unification of critical disciplines and their formulation as a metaphilosophy constitute a major contribution, as yet unrecognized outside China, to the General Theory of Information. I conclude further that the theories described in this paper constitute part of a new transdisciplinary paradigm, in which information has a central role in the transformation of the society and its approach to knowledge and the classical separation of the academic disciplines. In fact, Wu's approach constitutes and new, original and in my view necessary critique of the bases of modern philosophy as a whole. Application of my interpretation of the Logic in Reality together with Wu's Metaphilosophy of Information could be a useful new strategy for resolving critical outstanding issues in the field of information and provide further support for an ethical development of the Information Society.

Bibliography

[Allaby, 1998] M. Allaby. A Dictionary of Plant Sciences. Oxford University Press, Oxford.

[Brenner, 2008] J. E. Brenner. Logic in Reality. Springer, Dordrecht.

[Brenner, 2009] J. E. Brenner. Prolegomenon to a Logic for the Information Society. triple-c 7(1): 38-73. http://www.triple-c.at.

[Brenner, 2010] J. E. Brenner. Information in Reality: Logic and Metaphysics. Paper, 4th International Conference on the Foundations of Information Science, Beijing, August, 2010.

[Brenner 2010a] J. E. Brenner. The Logic of Ethical Information. In: Knowledge, Technology, Policy. Ed. H. Demir, 23(1-2), 109-133.

[Brier, 2008] S. Brier. Cybersemiotics. Why Information is not enough. University of Toronto Press, Toronto.

[Burgin, 2010] M. Burgin. Theory of Information: Fundamentality, Diversity and Unification. World Scientific, New York/London/Singapore

[Burgin and Brenner, 2010] M. Burgin and J. E. Brenner. Operators in Nature, Mind and Society (in press).

[Cao, 1997] T. Y. Cao. Conceptual Developments of 20th Century Field Theories. Cambridge University Press, Cambridge, U.K..

[Capurro, 1996] R. Capurro. Information Technologies and Technology of the Self. Journal of Information Ethics 5:2, 19-28.

[Capurro, 2008] R. Capurro. Information Technology as an Ethical Challenge. ACM Ubiquity 9:22.

[Castells, 2000] M. Castells. The Information Age: Economy, Society and Culture. Volume I The Rise of the Network

Society (2nd Ed.). Blackwell Publishing, Malden-Oxford-Carlton.

[Finlay and Schroeder, 2008] S. Finlay and M. Schroeder. Reasons for Action: Internal vs. External. In: The Stanford

Encyclopedia of Philosophy (Fall 2008 Edition). Ed. E. N. Zalta. URL =

http://plato.stanford.edu/archives/fall2008/entries/reasons-internal-external/ .

[Floridi, 2004] L. Floridi. Open Problems in the Philosophy of Information. Metaphilosophy 35(4): 554-582.

[Floridi, 2006] L. Floridi. The Logic of Being Informed. Logique et Analyse 49(196): 433-460.

[Floridi, 2008] Floridi, L. Information Ethics: Its Nature and Scope. In: Moral Philosophy and Information Technology.

Eds. J. van den Hoven and J. Weckert. Cambridge University Press, Cambridge, U.K., 40-65.

[Floridi, 2010] L. Floridi. The Philosophy of Information. Oxford University Press, Oxford.

[Franssen et al., 2010] M. Franssen, G.-J. Lokhorst and I. van de Poel. The Philosophy of Technology. In: The Stanford

Encyclopedia of Philosophy (Spring 2010 Edition). Ed. E. N. Zalta.

URL=http://plato.stanford.edu/archives/spr2010/entries/technology/

[Hofkirchner, 2009] W. Hofkirchner. How to achieve a unified theory of Information. triple-C 7(2), 357-358.

http://www.triple-c.at/index.php/tripleC/article/viewFile/114/138/.

[Introna, 2005] L. Introna. Phenomenological Approaches to Ethics and Information Technology. In: The Stanford

Encyclopedia of Philosophy (Winter 2005 Edition). Ed. E. N. Zalta. URL =

http://plato.stanford.edu/archives/winter2005/entries/phenomenological-approaches/.

[Ladyman, 2010] J. Ladyman. The Scientistic Stance: the empirical and materialist stances reconciled. SYNTHESE 178:87-98.

[Leydesdorff, 2006] L. Leydesdorff. The Knowledge-Based Economy: Modeled, Measured, Simulated. Universal

Publishers, Boca Raton, Florida, 2006.

[Leydesdorff, 2009] L. Leydesdorff. Redundancy in Systems which Entertain a Model of Themselves: Interaction Information and

the Self-organization of Anticipation. Preprint for ENTROPY.

[Logan, 2010] R. Logan. What is Information? University of Toronto Press, Toronto.

[Lopes and Silk, 2010].I. Lopes and J. Silk. SCIENCE 330: 460-461

[Lovekin, 1977] D. Lovekin. Jacques Ellul and the Logic of Technology. Man and World 10(3): 251-272.

[Lupasco, 1967] S. Lupasco. Qu'est-ce qu'une structure? Christian Bourgois, Paris.

[Lupasco, 1973] S. Lupasco. Du devenir logique et de l'affectivité; Vol. 1: Le dualisme antagoniste. Essai d'une nouvelle théorie de la connaissance. J. Vrin, Paris. (Originally published by J. Vrin, Paris, 1935).

[Magnani, 2002] L. Magnani. Preface to Model Based Reasoning: Science, Technology, Values. Eds. L. Magnani and N.J. Nersessian. Kluwer, Dordrecht.

[Magnani, 2007] L. Magnani. Morality in a Technological World. Knowledge as Duty. Cambridge University Press, New York.

[Mindell, Gerovitch 2003] D. Mindell and S. Gerovitch. Cybernetics and Information Theory in the United States, France and the Soviet Union. Science and Ideology: A Comparative History, M. Walker (dir.). Routledge, London, 66-95.

[Mortensen, 2008] C. Mortensen. Change. In: The Stanford Encyclopedia of Philosophy (Fall 2008 Edition). Ed. E. N. Zalta. URL=http://plato.stanford.edu/archives/fall2008/entries/change/

[Nicolescu, 2002] B. Nicolescu. Manifesto of Transdisciplinarity. State University of New York Press, Albany, New York,

[Quieroz et al., 2008] J. Quieroz, C. Emmeche and C. N. El-Hani. A Peircean Approach to 'Information' and its Relationship with Bateson's and Jablonka's Ideas. The American Journal of Semiotics. 24 (1-3): 75-94

[Rosenberg, 2002] J. Rosenberg. Wilfrid Sellars. In: The Stanford Encyclopedia of Philosophy (Summer 2006 Edition). Ed. E. N. Zalta. http://plato.stanford edu/archives/sum2006/entries/sellars/.

[Sagüillo, 2009] J. M. Sagüillo. One Sense of Information A Quick Tutorial to Information-Theoretic Logic. triple-C 7 (12): 179-184.

[Seibt, 2009] J. Seibt. Forms of Emergent Interaction in General Process Theory. SYNTHESE 166:479-512.

[Sequoiah-Grayson, 2007] S. Sequoiah-Grayson. The Metaphilosophy of Information. Minds & Machines 17:331-334.

[Tavani, 2007] H. T. Tavani. Ethics and Technology. In: Ethical Issues in an Age of Information and Communication Technology. http://www.wiley.com/college/tavani. John Wiley &Sons.

[Toulmin, 1976] S. E. Toulmin. Knowing and Acting. An Invitation to Philosophy. Macmillan, New York/London.

[van Fraassen, 2002] B. C van Fraassen. The Empirical Stance. Yale University Press, New Haven.

[Wheeler, 1990] J. A. Wheeler. Information, Physics, Quantum: The Search for Links. In: Complexity, Entropy, and the Physics. Ed. E. Zurek. Addison-Wesley, Redwood City, California, 3–28.

[Wu, 1989] K. Wu. Philosophy of Information — a New Spirit of the Time. Shaanxi Normal University Press, Xi'An.

[Wu, 2009] K. Wu. Basic philosophical questions and the fundamental philosophical shift. In: Third session Forum participants Social Science in Chain Frontier Forum Papers. September, 2009, Xi'An.

[Wu, 2010] K. Wu. The Basic Theory of Philosophy of Information. Paper, 4-th International Conference on the Foundations of Information Science, August, 2010, Beijing.

Author Information

Joseph E. Brenner *-International Center for Transdisciplinary Research, Paris.*

P. O. Box: 235, Les Diablerets-1865, Switzerland; e-mail: brenner52@sbcglobal.net

Major Fields of Scientific Research: Logic, philosophy, epistemology

GOD-ICS. ON FUNDAMENTAL INFORMATION FIELD QUEST

Vitaliy Lozovskiy

Abstract: *Further progress in AI research requires more complete and comprehensive study of information interactions in nature, not confined to psyche and intellect of individuals. One should not ignore evidences in favor of "unconventional" information interactions. The paper deals with two aspects of this research: from the viewpoint of physics of the microworld, and improving accuracy and correctness of the experimental studies. Is introduced the concept of "natural science" God - God-ICS. Are examined some arguments in favor of fundamental information field existence. Is considered the concept of non-locality, introduced in quantum mechanics, "spooky action at a distance" and experiments admittedly demonstrating their reality. Proposed is an idea of the RNG-controlled two-slit experiment. The relation between reality and modeling it theories is specified, which quantum mechanics still manages to safely get around. Critically considered is one of the well-documented experiments on registration of psychic phenomena, identified is the need for careful research and parameters selection for control random sequences. Ignoring this aspect may lead to erroneous conclusions regarding the "detection" of phenomena on the verge of accuracy and reliability of measurements, uncertainties in their statistical representativeness. Proposals for further research in this area are formulated.*

Keywords: *philosophy, noosphere, esotericism, intangible world, mystic theories, consciousness, mind-matter interaction, quantum mechanics, nonlocality.*

ACM Classification Keywords: *A.0 General Literature - Conference proceedings, G.3 PROBABILITY AND STATISTICS - Random number generation, H.1.1 Systems and Information Theory (E.4), I.2 ARTIFICIAL INTELLIGENCE - I.2.0 General: Cognitive simulation, Philosophical foundations, I.6 SIMULATION AND MODELING (G.3), I.6.5 Model Development - Modeling methodologies, J.2 PHYSICAL SCIENCES AND ENGINEERING - Physics*

It is often stated that of all the theories proposed in this [20th] century, the silliest is quantum theory. In fact, some say that the only thing that quantum theory has going for it is that it is unquestionably correct.

Michio Kaku, Hyperspace

Introduction

Almost in all spheres of human activity contemporary technical progress leaves far behind the wildest fantasies of science fiction writers. Only AI, generally speaking, fails to demonstrate stunning breakthrough achievements. I thought that maybe we failed to take into consideration or underestimated something important in the domain of our research. Probably, we are not fully aware about deep information processes in humans, human societies, physical world, noosphere. It appeared that, besides psychology and neurobiology, beyond scientific approach to Nature cognition, there exist impressive stratum of esoteric teachings and traditions, which are also trying to explore human beings in the context of their relationships to nature and other humans.

Immersion in esotericism [Lozovskiy, 2003-2010] shed upon me, some light concerning its problem domain. It became clear that human psyche and mentality has outstanding neurosomatic influence on one's body and integral personal functionality. Thus, meditation, autosuggestion, broad spectrum of practices in altered states of consciousness can stimulate overall health improvement and even cure some functional disorders. Official neurology and psychiatry gradually change their until recently negative attitude to these practices. But one problem turned out to be a hard nut. And that was the problem of God. Recently [Lozovskiy, 2007b] I tried to consider it from different viewpoints. The most constructive approach to the concept of God turned out to be the concept of God-ICS.

God-ICS - Information & Control System

I nominate as determining two of the most "God-like" concepts: information and control. What would be (presumably existing) God, we must agree that these concepts should be leading. God having no control ability...(?) And is it possible to manage without information, without actual knowledge? This question is clearly purely rhetorical. We can endow God with many other properties and values, but these two are undoubtedly absolutely necessary. In addition, it is to a certain extent, an attempt to speak more precisely - avoiding talk about omniscient and omnipotent God, karma, destiny, etc. On the one hand, this approximation implements generally adopted ideas about God, but on the other - they admit experimental verification. This is something that other definitions of God miss: the real possibility of materialistic confirmation of its existence.

Let us define ***"Bioinformatics"*** as *unconventional information exchange between living organisms, or between a living organism and inanimate object that cannot be attributed to well-known for today science techniques with the help of optical, acoustic and electromagnetic waves and other means of "classical" media based interaction.*

Esoteric sources are full of manifestations of Esoteric Phenomena, Extrasensory Perception (EP, ESP): telepathy (information exchange between higher mammals, including humans) and clairvoyance (the ability of a person "to see with their mind's eye" something that is outside the capabilities of conventional sight), remote viewing. Sometimes occurs the term "clairsentient" - when a person allegedly receive information from those areas of knowledge, where they are not specialist. Often is mentioned extremely large distance between the sender and the recipient of telepathic information, which, considering signal attenuation and the allowable noise levels may be many times higher than the capabilities of traditional communication systems. Moreover, there are rumors about independence of telepathic communications from distance. Many talk about the possible existence of a certain Fundamental Information Field (FIF), which supposedly captures all the informational events on Earth, and to which is possible, in principle, to apply for the necessary information. Thus, it is instructive to define such prospective entity: ***God-ICS (Information & Control System)*** which "handles" data and knowledge base: FIF and admittedly is able to organize (and control) processes ("physical laws") in the Universe.

It is easy to spot suspicious resemblance between the notion of FIF and ideosphere (cultural) [Lozovskiy, 2003]. If the latter is an indisputable part of our noosphere, the existence of FIF should be shown through reliable natural science experiments. Unfortunately, majority of the currently available evidences of EP, particularly, telepathy and clairvoyance, upon closer examination raise serious doubts concerning their authenticity. Solution there can be only one - holding a pure experiment, excluding uncertain results and sensory leakage (information transfer through ordinary sensory channels).

Discovery of FIF would entail a number of fundamental issues: concerning the language and encoding methods used, discovering the material carrier of this information and so on.

Idealistic approach to universe genesis and foundation seems to be unreasonable. Suppose that God is "the world programmer" and material world is only programs in the Divine Computer. Even in this case this computer and its "programmer" should be material. In other words, it turns out that the materialistic approach has no alternatives.

Proposed approach to the concept of God-ICS seems to be very helpful. First, it stipulates the mandatory functions, which must necessarily be present at supreme "divine" level. Secondly, appears a real possibility to prove the existence of such God by a natural science experiment. At, least, we are talking about the first issue - information storage and handling which should be necessarily present if EP exist in reality. Despite abundant "evidences" that existence of these phenomena have already been "scientifically proven", in my opinion, it is far not so.

In my God-ICS hypothesis there is certain questionable issue. It is assumed that experiment on EP should be performed in the process of interaction between humans. Therefore, if the experiment would be crowned with success, we will get answer concerning abilities of persons involved, and not God. The question arises: how then we may say that this is, at least, "God-supported" activity? I would say that the informational impact on the world by God, should be limited within the level of humans and higher mammals. The rest of the world obeys to physical and chemical laws.

The second issue: suppose the recipients in EP experiments hopelessly fail. Opponents will immediately argue: just the language of God is not available to mortals, even psychics. But then - with whom God communicates in such incomprehensible language? With another God? Himself? Then the following argument: if these prospective exchanges of information do not affect the physical world and the psyche of people - we can assume that these processes are simply absent. Any study begins with the detection of a miracle - violations of the causal chain of events which cannot be explained at an affordable level of knowledge. No effect - there is no reason to look for cause.

Besides efforts for God-ICS disclosing, it is instructive to note the following. Assume for a moment that the existence of God-ICS is confirmed. It will mean that in nature there are real tangible aspects of his existence. Thus, theoretical physicists have to give a reasonable formal theory, experimental physicists - invent, implement and evaluate experiments, which would confirm these theories.

If and when such efforts succeed, the concept of God-ICS will be demystified and it will peacefully dwell within the materialistic paradigm.

Morphogenetic, or Akashic Field

The general conception of Fundamental Information Field (FIF) is very popular among esoteric authors. Here is idea of morphic field which is being developed by Rupert Sheldrake:

"The morphic fields of social groups connect together members of the group even when they are many miles apart, and provide channels of communication through which organisms can stay in touch at a distance. They help provide an explanation for telepathy. There is now good evidence that many species of animals are telepathic, and telepathy seems to be a normal means of animal communication... Telepathy is normal not

paranormal, natural not supernatural, and is also common between people, especially people who know each other well" [Sheldrake].

Ervin Laszlo [Laszlo, 2003, 2004] in the quest for "The Integral Theory of Everything" substantiates the existence of a some fundamental field, primordial construction material of the Universe. He uses the term: "Akasha", "Akashic field", or simply "A-field": "In the Sanskrit and Indian cultures, Akasha is an all-encompassing medium that underlies all things and becomes all things. It is real, but so subtle that it cannot be perceived until it becomes the many things that populate the manifest world… According to the philosophers of India, the whole universe is composed of two materials, one of which they call Akasha. It is the omnipresent, all-penetrating existence. Everything that has form, everything that is the result of combination, is evolved out of this Akasha.

… In the case of the field that could account for the presence of information in nature, the evidence is the puzzling, quasi-instant form of coherence that comes to light in the physical, cosmological, and biological sciences, as well as in consciousness research. These phenomena call for an explanation, and the simplest and most logical explanation is a field that links the entities that prove to be nonlocally coherent.

... Although fields, like other entities, are not to be multiplied beyond the scope of necessity, it seems evident that a further field is required to account for the special kind of coherence revealed at all scales and domains of nature, from the microdomain of quanta, through the mesodomain of life, to the macrodomain of the cosmos.

… Scientists now realize that space is not empty, and what is called the quantum vacuum is in fact a cosmic plenum. It is a fundamental medium that recalls the ancient concept of Akasha… In the next development of science, the A-field will join the currently known universal fields: the G-field, the EM-field, the Higgs field, and the locally effective but universally present strong and weak nuclear fields.

…In this concept the universe is a highly integrated, coherent system: a "supermacroscopic quantum system." Its crucial feature is in-formation that is generated, conserved, and conveyed, and links all its parts. This feature is entirely decisive. It transforms a universe that is blindly groping its way from one phase of its evolution to the next into a strongly interconnected system that builds on the in-formation it has already generated".

Frankly speaking, substantiations underlying the possible existence of FIF, morphogenic, Akashic, Ganzfeld, torsion, ether and many other hypotheses about Universe foundations seems very problematic. My opinion is that to these studies should not be indiscriminately glued the label of pseudoscience erecting quantum mechanics (QM) on an inaccessible for criticism the sacred pedestal on which earlier dwelt classical physics.

The fundamental question to be answered by physics - classical, quantum or some future, which will come to augment them - is a question of existence of non-local, long-range communications and interactions - not **at** the level of mathematical formalism**,** but at the level of immediate physical reality. Unfortunately, it is not so easy. Too many inaccuracies, contradictions and just unfounded claims have grouped around these issues. I believe that the problem lies in the fact that some researchers neglect the relation between reality, pseudo-physical model and the mathematic formalism in the process of world cognition. This issue I am going to elaborate on below.

Double-slit Experiment

Physics is not that place, where miracles and paradoxes feel themselves carefree and comfortable. Miracles are natural phase of research efforts. After encountering a miracle researcher works out its explanation or develops a new natural science theory. Sound science should expel paradoxes and contradictions from its body. Thus was in "classical" physics until quantum mechanics (QM) sprang into existence. Even more... QM until these days has

no sound interpretation adopted by majority of physicists. Calculations performed according to its formulas give excellent results when applied to experimental data without self evident model explanation - as it was in good old times of classic physics. To Richard Feynman belongs the authoritative affirmation: *"I think I can safely say that nobody understands quantum mechanics"*. David Mermin confessed: *"If I were forced to sum up in one sentence what the Copenhagen interpretation says to me, it would be "Shut up and calculate!""* The most provocative issue of QM is its relationship with the concepts of information and consciousness. That is why I became interested in QM. My initial impressions concerning these issues were presented in [Lozovskiy, 2009].

Consider the classic double-slit experiment (Fig. 1). The source of tiny particles emits them one by one toward a plate (wall) with two slots: 1 and 2. After flying through them they hit the screen (backstop).

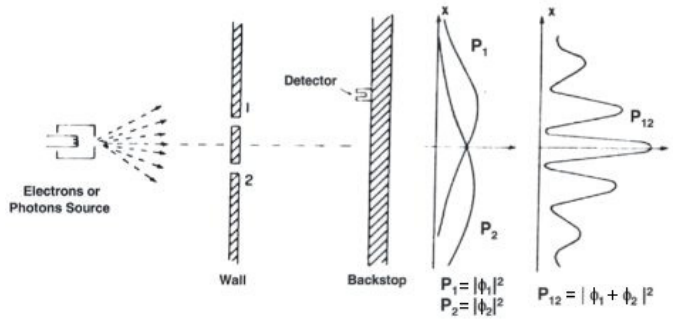


Fig. 1 Double-slit experiment; influence of detector

In microworld particles have also wave properties. The famous particle-wave dualism... In any case, if we do not misuse our curiosity about which slot each particle flies through, our particles will behave like waves: on the backstop screen will clearly develop density fringes (right graph) - the traditional interference pattern (IP). Here the mystery arise. When we deal with waves on water surface, it is quite natural to observe IP between two wave sources. Would be our two slots subjected, say, to light ray - we could consider them as two secondary sources of light giving IP on the screen. But we manipulate with solitary particles. With what they interfere during their flight to the screen? The second enigma is: electrons (or photons) are emitted from the source as particles. And they hit the screen as particles - leaving the corresponding trace. Where from comes its wave-like behavior? QM has its answer: movement of particles is done in accordance with wave function... which collapses to the specific particle when hitting the screen... So, the particle during its flight is sort of wave... which comes through both slots simultaneously.

If we do not like the idea of, say, electron coming simultaneously through both slots and will put some detector - it will inform us quite intelligibly that it passed through slot 1, or if not - it is evident that it has went through the slot 2. Fine! But in that case the IP will be gone: we will register the sum of two smooth particle distributions: P1 and P2 - behind slot 1 and 2 respectively. Here appears an esoteric idea about influence of our consciousness, our attention on physical world: if we expect from particles wavelike behavior - they are waves. If we consider them to be particles - they silently obey.

Materialistic approach to this experiment inclines us to believe that probably not our consciousness, attention or attitude influences our research facility, but quite mundane things: detectors, for example. Inserting bulky thing into our device inevitably changes its internal geometry, resonance characteristics, disrupts oscillations, drastically changes the state of our micro particles - and IP disappears. It would be quite plausible assumption -

to hold to the idea of particles following all their way from the source to the target. Thus, appearance of IP itself could be the joint effect of our device geometry and specific distortions of particles' trajectory.

In any case, it would be instructive to study in detail the mechanism of experimenter influence on the experiment. First of all, one could place into the installation dummy sensors that are identical in size and material to the real ones. Then - install sensors not connecting them to the recording equipment. Then perform the experiment in automatic regime in experimenter's absence. I have no information if anybody performed such tests in reality, not as Gedankenexperiment.

However, this simple "classical" explanation hangs in the air when considering more sophisticated experimental installations - a delayed choice quantum erasers, for example. This experiment is very popular among QM-physicists. But before that we should clarify the notions of non-locality and the possibility of "spooky actions at a distance", as A.Einstein used to call them.

Non-locality and No-communication Theorem. Spooky Actions and Communications

I touched this issue earlier [Lozovskiy, 2009]. In two words, non-locality is an exotic notion introduced in QM. Physicists believe that it accompanies the phenomenon of entanglement. According to Wikipedia, *"quantum entanglement is a property of the quantum mechanical state of a system containing two or more objects, where the objects that make up the system are linked in such a way that the quantum state of any of them cannot be adequately described without full mention of the others, even if the individual objects are spatially separated"*. According to Copenhagen interpretation of QM, spatially separated entangled objects have no hidden parameters, for example, electron spins (if they were spin-entangled). Objects can be billion light years apart, still (from QM viewpoint) they remain one unified object. The measurement of spin for one object makes the other object ***at the same moment*** obtain the complementary spin value. This outcome suggests transmission of information over any distance at superluminal speed, which is impossible according to the STR - ***special theory of relativity***. It is really strange: laws of STR and of QM - both accepted theories - are mutually contradictive. Einstein mocked at QM calling such effects *"spooky action at a distance"*. Of course, in this vein, we could talk also about spooky communications... And it would be the long searched support for esoteric ideas about reality of EP.

One more argument against the feasibility of EP stems from no-communication theorem [Peres, Terno, 2004]. Considering the possibility of instantaneous interaction between distant partners: Bob and Alice, they prove: *"The statistics of Bob's result are not affected at all by what Alice may simultaneously do somewhere else. This proves that … indeed is a sufficient condition for no instantaneous information transfer"*. The same conclusion can be found in Wikipedia: *"In quantum information theory, a no-communication theorem is a result which gives conditions under which instantaneous transfer of information between two observers is impossible. These results can be applied to understand the so-called paradoxes in quantum mechanics such as the EPR paradox or violations of local realism obtained in tests of Bell's theorem. In these experiments, the no-communication theorem shows that failure of local realism does not lead to what could be referred to as "spooky communication at a distance""*.

Thus, at the moment we have not received convincing evidence from physics on feasibility of EP.

A Delayed Choice Quantum Eraser

Let us consider the paper [Kim et.al, Rhodes, 2000], which includes fragments of original paper by Y-H.Kim with his co-authors and analytic remarks done by Ross Rhodes. The illustrations are taken from their paper.

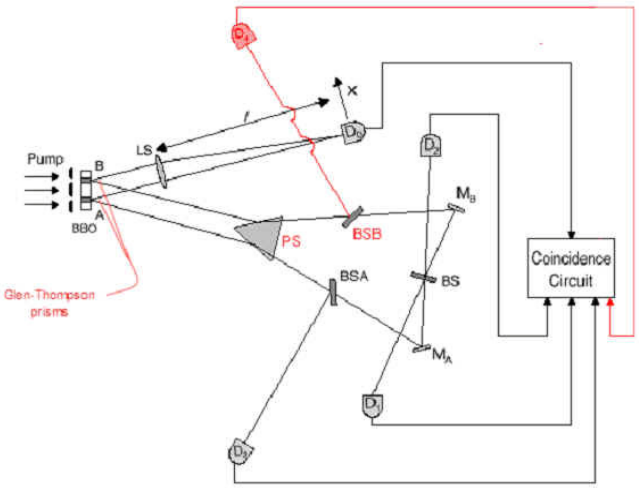


Fig. 2 Delayed Choice Quantum Eraser

The schematic diagram of the experimental setup is shown in Fig. 2. Solitary photons from a pump laser are randomly one by one scattered onto optical crystals: ***A*** and ***B*** which play the role of double slits. Their output are the pairs of orthogonally polarized entangled signal-idler photons. Signal photons fly upwards towards detector D_0 and produce an IP which can be displayed. Their entangled twins - idler photons run their path downwards to the prism PS. When an idler photon hits the upper face of the prism, we know that they both with twin signal photon left the slit ***B***. If an idler photon hits the lower face of the prism - it means that it and the corresponding signal photon were produced by the slit ***A***. Here's how exceedingly carefully is generated in the installation which-path information about the slit which provided each signal photon directed to the detector D_0.

The idler photons next encounter beamsplitters: BSA or BSB which in 50% cases reflect these photons towards the detectors D_3 or D_4 leaving which-path information intact, otherwise they pass through towards the mirrors M_A or M_B. There they get into the quantum eraser scheme with the detectors: D_1 and D_2. Eraser scheme also uses 50/50% beamsplitter ***BS***. When detector D_1 receives some idler photon - there is no means to say which slit (***A*** or ***B***) produced it: it might came from M_B mirror signaling that its source was slit B, or it might came due reflection from the mirror M_A. And it would mean - from ***A***-slit. Thus, which-path information is efficiently erased: remains only the synchronizing pulse signaling about arrival of the corresponding signal photon to detector D_0. Detector records the resulting integrated graph that depict all signal photons and can be scanned along its *x*-axis by a step motor. Coincidence Circuit allows one to select from the general flow of signals to D_0 - only those signals, which meet the conditions specified by the experimenter. The experimental setup ensures that **this which-path information for the signal photons is obtained or erased only *after the signal photon has been detected* and the information is winging its way toward the Coincidence Circuit.**

The detection event at detectors D_3 or D_4 gives us which-path information about a photon that was previously registered at detector D_0. The scanning has registered where it hit D_0 – along the D_0 *x*-axis. But when we

correlate the later detection of the idler at D_3 or D_4, with that previous detection at D_0, we now know postfactum (!) that the photon registered at D_0 came from either region A or region B of the crystal.

Experimenter obtains specific graphs extracted from the "raw" D_0 mess: R (Fig. 3) - obtained on the basis of signals from quantum eraser (D_1 or D_2) and R_{WP} (Fig. 4) - correlated with the signals from which-path detectors (D_3 or D_4).

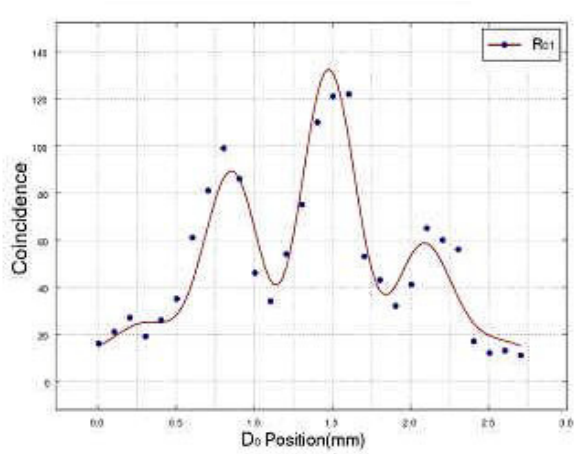


Fig. 3 Interference pattern R - no which-path information

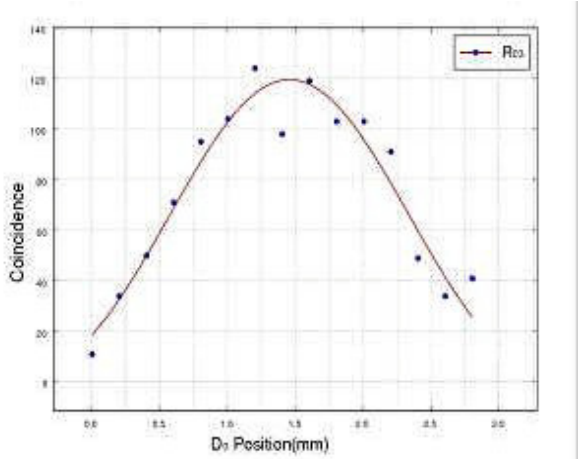


Fig. 4 Interference pattern R_{WP} - which-path information registered *a posteriori*

This experiment is much more accurate than the basic double-slit experiment. Following Ross Rhodes, let us reconsider the main stages of the experiment.

1. "The entangled pair leaves either region ***A*** or region ***B***. The signal photon heads off to detector D_0, and the idler photon heads off to the interferometer.
2. The signal photon is registered and scanned at detector D_0 according to its position. This information is sent on its way to the Coincidence Circuit.

The idler photon reaches the first pair of beamsplitters, BSA, BSB. There, QM makes a choice which direction the idler photon will go – either to detectors D_3, D_4; or to the quantum eraser BS and on to detectors D_1, D_2.

(a) If the idler photon is shunted to detectors D_3, D4, it is detected with which-path information intact. Then and only then do we know which-path information for its twin signal photon that already has been detected, scanned, registered and recorded at D_0, or:

(b) If the idler photon passes through to detectors D_1, D_2, it is detected with no which-path information (the which-path information having been "erased" at BS).

The Coincidence Circuit correlates the arrival of a signal photon at detector D_0 with the arrival of its twin at D_1, D_2, D_3, or D_4. If the correlation is with an idler arriving at D_3 or D_4, then we know (after-the-fact) the which-path information of the signal photon that arrived earlier at D_0. If the correlation is with an idler arriving at D_1 or D_2, then we have no which-path information for the signal photon that arrived earlier at D_0.

Upon accessing the information gathered by the Coincidence Circuit, we the observer are shocked to learn that the pattern shown by the positions registered at D_0 at #2 depends entirely on the information gathered later at #4 and available to us at the conclusion of the experiment".

In this accurate and sensible description Ross formulated one questionable item, namely, #7. Future can have no effect on the past. The detection time of the signal photon (***D_0***) is 8 ns earlier than that of the idler. Really, at moment #2 signal photon places itself peacefully on the detector ***D_0*** screen. And nothing can change this situation. Nevertheless, one can make the following remarks.

Kim and his co-authors in their paper specify that detectors ***D_1*** - D4 were positioned ≈2.5 m. away from the slit than the signal detector ***D_0*** - that gives the mentioned time delay of 8 ns, while the crucial event happens much earlier: when the idler photons interact with beamsplitters ***BSA*** or ***BSB*** - either they pass through them to the quantum eraser scheme, or they are reflected towards detectors ***D_3*** or ***D_4*** which provide which-path information. So we have no certitude: whether at this moment the corresponding signal photon had already struck its ***D_0*** target, or not yet.

1. Authors do not give sensible explanation to this experiment. They write: "... experimental results, …are all consistent with prediction... To explain the experimental results, a standard quantum mechanical calculation is presented..." The blatant demonstration of the Mermin's slogan: ***"Shut up and calculate!"***
2. If the experimental setup did not contain flaws or inaccuracies, the reader should start to believe that entangled pairs of signal and idler photons really behave coherently: if there exist which-path information, the signal twin behaves itself as a particle. And if not - as a wave-model subjected entity - participating in building IP. This is in contradiction with No-communication theorem.

Evaluating the considered experiment, we must recognize its accuracy and wit. Unfortunately, its authors failed to present a meaningful explanation of the observed effect, while at the same time exposing the contradictions between QM and STR. Though, I think, allegedly demonstrated correlation, synchronicity in the behavior of entangled photon pairs is an argument in favor of the reality of the existence of non-local effects. This is precisely the consideration that could support the existence of FIF - some or other sort.

Nostalgia for Hidden Variables

Idea of hidden variables at the microcosm level was desperately supported by Albert Einstein. In contrast to Copenhagen interpretation of QM which considered the properties of particles appearing during the measurement, Einstein believed that properties of physical objects should be their unalienable feature. He believed that QM rejecting this idea is incomplete. These prospective properties were named ***"hidden variables"***. In theoretical physics, Bell's theorem (a.k.a. Bell's inequality) [Bell] loosely state that no physical theory of local hidden variables can reproduce all of the predictions of quantum mechanics. Experiments of Alain Aspect showed: "The violation of Bell's inequality, with strict relativistic separation between the chosen measurements, means that it is impossible to maintain the image 'à la Einstein' where correlations are explained by common properties determined at the common source and subsequently carried along by each photon… In some sense, both photons keep in contact through space and time" [Aspect]. Subsequent experiments of various researchers showed that this conclusion is correct.

But... but believing in this brings us to strange deductions: keeping the contact through space at superluminal speed is "spooky actions at a distance" as Einstein called it... It brings to us marvelous, magic effects with which we have met earlier in this paper considering a delayed choice quantum eraser [Kim et.al, Rhodes, 2000].

There is evident remedy against such quantum magic. It is that same officially rejected idea of hidden variables. I cannot give neither theoretical, nor experimental confirmations of this desperate proposal, but such hypothesis can swap away this strange and self-contradictory magic.

Let us return to Fig. 2. The key elements for our consideration are two beamsplitters: ***BSA*** and ***BSB***. If idler ***A*** or ***B*** photon passes through any beamsplitter it will be captured by quantum eraser scheme. Coincidence circuit will be activated, and the corresponding signal photon which up to this point went upwards will be registered by detector D_0, as participating in building IP. If ***BSA*** or ***BSB*** will reflect an idler photon towards D_3 or D_4 detectors - which-path information remains intact, and corresponding signal photon should "become" non-pattern one. Thus, in reality D_0 registers the mixture of IP and non-IP photons. Coincidence circuit helps separate these pictures.

What can pull off veil of mystery off this experiment? Just simple assumption. Assume that photons have certain hidden discriminating parameter with only two possible states: $S = 0$ and $S = 1$ with equal probability of occurrence: 50%. Idle and signal photons should have identical S. Next, let's beamsplitters let pass idle photons through (which-path information erased) if $S = 0$, and reflect (which-path information kept) if $S = 1$. Their signal twins behave themselves differently: if $S = 0$, they participate in IP creation, otherwise - not. The behavior of the experimental setup is exactly the same as presented before, but all the mysticism evaporates without a trace. Discriminating hidden variables eliminate the issue of the causality violation and of consciousness influence on photon's behavior.

Of course, the whole experiment is not explained in details yet. The mechanism of possible interaction of photons under control of prospective S-parameter is to be found, but the reward for this would be banishing mysticism from physics. Decent deal, right?

The issue of possible rehabilitation of the hidden variables idea attracts more and more researchers; see, for example, [Hemmick].

RNG Double-slit Experiment

Reticence, obscurity and contradictions of the many experimental setups have led me to propose more thoroughly controlled version of double-slit experiment (Fig. 5). Instead of using one electron gun irradiating double-slit shield, two guns are provided, each one sending electrons to only one slit. If in traditional scheme slits are chosen at random angles, in proposed setup this process can be under control.

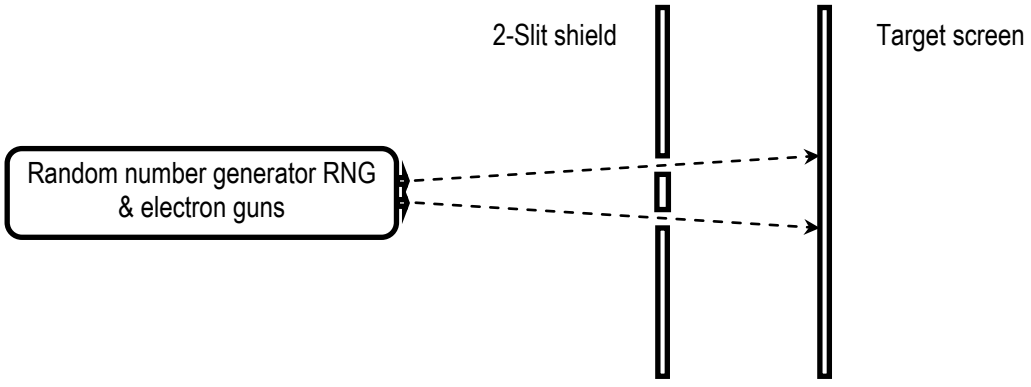


Fig. 5 RNG Experiment

The experiment itself comprises the following steps and considerations.

1. Generation of electrons is done one by one. Experiment is conducted during time period required for perfect depiction of IP (or unimodal distribution) on the target screen.
2. Choosing upper or lower gun is done under control of physical RNG, say, on the base of Zener diode. Thus we have absolutely no possibility to obtain which-path information. Functionality of such RNG-guns is exactly equivalent to traditional setups used in classical experiments, when some electrons settle themselves on the shield, some fly through one slot, while others through the second. If no magic involved, at this stage we should see the classic IP (having no which-path information).
3. Physical RNG is replaced by pseudorandom subroutine with uniform 0 .. 1 (upper .. lower slit) distribution. Of course, its randomness should be carefully tested. Physically, nothing has changed in functionality. If IP disappears - it would mean that *electrons have wits and suspiciousness* …
4. Next, we register the gun's control series in computer memory. By the way, it could be done in both configurations: not only for pseudo RNG, but for physical one - all the same.
5. At last, physicist-specialist comes to computer and studies the whole protocol of the experiment. Here we can simulate any experiment of "delayed" collapse type resembling also that of Wigner's friend - Schrödinger's cat variety. Namely, let technical assistant comes to the computer display and prepares protocol printouts. Then assistant handles the protocol to the specialist, and experimental results can be analyzed thoroughly in completeness. Hope, all this magic will have absolutely no influence on the results of the experiment.

Perception, Paradigms, Pseudo-physics, Formal Models of Reality and Gedanken Experiments

I sincerely believe these issues are trivial. Astonishing is their apparent neglect from the side of some specialists. Consider relationship between some applied formal theory and reality (Fig. 6). The leading role in the process of reality cognition plays the choice of paradigms for perception of its entities and phenomena. It is done on the purposes-oriented basis including means of monitoring the process and performing the necessary measurements. Next comes the model level. Model is a physical, semiotic (in computer memory) or mental (in the researcher's consciousness) construct which supposedly captures essential for the investigation features of the phenomena being studied. Model reflects researcher's understanding of the phenomena, and, of course, even having common specific paradigm, there may exist different models presumably explaining its "internal interactions".

On the top level may reside some formal theory which is the basis for exact calculations. Since we are discussing not purely mathematical theories, but theories of applied character, such theory not only should be internally non-contradictive, but it should be in good correspondence with processes in its application domain: physical reality, in our case. That is why so important is interpretation of the theory - presentation of its model, relation with a huge bulk of proven and verified physical theories and natural science laws, answering innumerable bulk of why- type questions.

QM is a strange exception in this respect. That is why Richard Feynman said: *"I think I can safely say that nobody understands quantum mechanics"*. Due to the complexity, high cost, technical difficulties, and often even impossibility under the current state of technology to perform these or other subtle physical experiments sometimes resort to so-called Gedanken (thought) experiments. The well known example is EPR-experiment [Einstein et al, 1935]. In my opinion, such subterfuge only creates the appearance of modeling, experimenting

within reality domain. Natural science experiments put to practical test the adequacy of a theory to physical reality, help to identify factors that were not taken into account or improperly reflected by the theory. Gedanken experiments solve neither of these problems - they just illustrate, retell formal theory with the help of thought example. Of course, results of such "experiment" coincide with theoretical predictions, by definition - there is no other alternative.

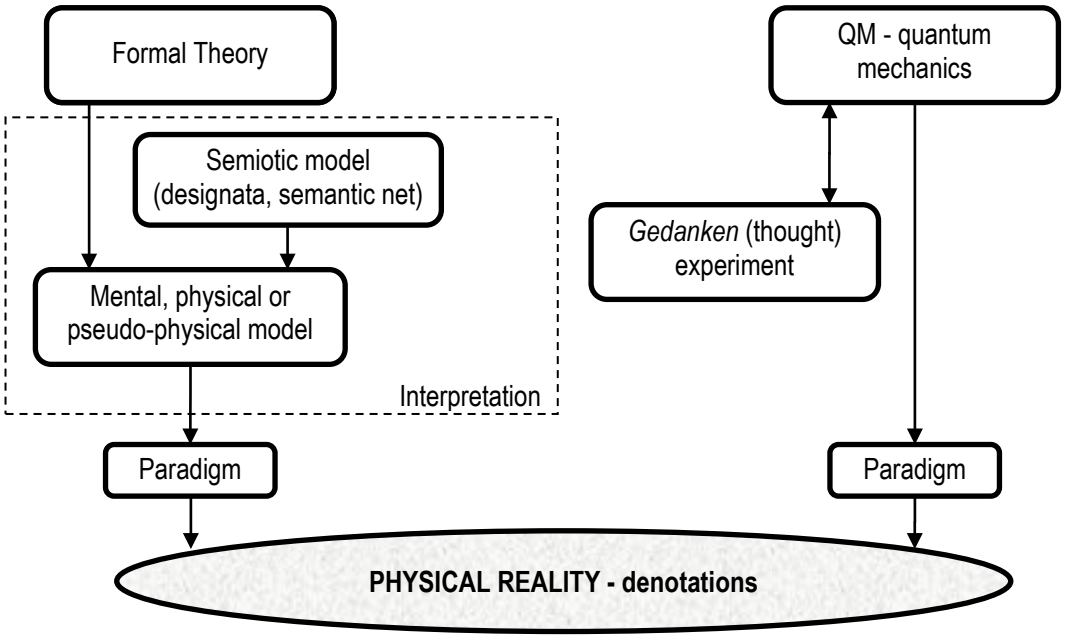


Fig. 6 Relation of formal theory to physical reality

That is why [Kim et.al, Rhodes, 2000] could not explain results of their magical experiment. They just managed to point out that their results are in exact correspondence with QM theoretical predictions.

The most serious drawback of this state of affairs lies in the temptation for theorists to project mathematical formalism of the theory directly onto the physical reality level. Really: "*In the beginning was the Word, and the Word was with God, and the Word was God*" - John 1:1 (1611 King James Bible). That is how idealism and religious legends find their way to modern physics, alas!

An example of these mechanical substitutions of "legal" pseudo-physical model by pure mathematics are many. Consider already mentioned here book [Laszlo, 2004]. The author discusses measurements on two entangled particles: A and B in Gedanken experiment EPR from [Einstein et al, 1935].

*"Every measurement on one particle yields a complementary outcome in the measurement on the other. It appears that the measurement of particle **A** has an instantaneous effect on **B**, causing its spin-wave function to collapse into the complementary state. The measurement on **A** does not merely reveal an already established state of B: it actually produces that state".*

Neither Copenhagen interpretation, nor Laslo do not give the explanation: how measurement can produce something which was absent before the act of measurement. By the way, no-communication theorem [Peres, Terno, 2004] prohibits influences of measuring state of one particle on the state of its entangled twin.

*"An instantaneous effect propagates from **A** to **B**, conveying precise information on what is being measured.*

***B** "knows" when **A** is measured, for what parameter, and with what result, for it assumes its own state accordingly. A nonlocal connection links **A** and **B**, notwithstanding the distance that separates them".*

That is how mysticism crawls into physics. QM-adepts cannot explain, why more "natural" representation is faulty: both particles from the moment of their preparation already had complementary, but unknown to experimenter spins. Measurement of spins are done corresponding to the axis of detector. Its cosine projection is detected (**+½ħ** or **-½ħ**) and depending on its sign, the result of measurement is "up" or "down". According to the particle preparation procedure, it is evident at the same moment and without any new actions that spin of the other particle is "down" or "up" - respectively. This approach does not require superluminal information (or action) transactions across gigantic distances. No violations of STR.

"Experiments performed in the 1980s by Alain Aspect and collaborators and repeated by Nicolas Gisin in 1997 show that the speed with which the effect is transmitted is mind-boggling. In Aspect's experiments the communication between particles twelve meters apart was estimated at less than one billionth of a second, about twenty times faster than the speed with which light travels in empty space, and in Gisin's experiment particles ten kilometers apart appeared to be in communication 20,000 times faster than the velocity of light, relativity theory's supposedly unbreakable speed barrier".

Much more natural explanation to these fantastic results is to explain them as just measurement errors: in ideal case, the "velocity of state propagation" should be infinite revealing zero time lag. But the real, not perfect quality of installations and measurement instruments used gave 20 times in one experiment and 20,000 times in other faster than light velocity. And it is quite understandable: if accuracy of measurement remains unchanged, increase in distance will lead to growth of "experimentally proven" speed of information exchange "between the particles" that we observe in the above quotation.

"The experiments also show that the connection between the particles is not transmitted by conventional means through the measuring apparatus; it is intrinsic to the particles themselves. The particles are "entangled": their correlation is not sensitive either to distance in space or to difference in time".

Right! No information in reality cannot be transmitted faster than light. If something is - it means that it is not information transfer, but something else... By the way, even QM itself does not promise the possibility of such transfers. Such is reality.

Until now physicist violently argue about "real" sense of J.Bell theorem and what proved the famous experiment of A.Aspect. The arguments concerns the existence of "hidden parameters" (for example, intrinsic spin of electrons). QM paradigm, is said, precludes it... but instead we obtain a handful of mystical or marvelous explanations, or no explanations at all. That is the price.

А был ли мальчик? Was there Really a Boy?

It is not a joke and far not the trivial question [Gorky]. I mean - all this fuss about reality of EP, FIF. Are there reliable natural science evidences that all these phenomena, experiences like telepathy, remote viewing, clairvoyance et al. really exist besides the artifacts in psychological sphere of humans with its aberrations, hallucinations and natural flaws of subject's memory? "Official" academic science says: - *No!* Dissidents and enthusiasts say: - *Of course, yesss! And it is scientifically proven!* Nevertheless, up to now I have no satisfactory, from my point of view, evidences concerning the existence of EP. But I am also against the orthodox and the

demagogic position of sweeping and absolute denying the possibility of the existence of phenomena unknown to science. Enthusiasts and proponents of alternative viewpoints should have the possibility to perform their studies, while their findings should be carefully and professionally considered by the scientific community. As an example of interesting study I decided to take [Bem, 2011].

Daryl gave the following definition of psi-phenomena: "*The term psi denotes anomalous processes of information or energy transfer that are currently unexplained in terms of known physical or biological mechanisms… Alleged psi phenomena include telepathy, the apparent transfer of information from one person to another without the mediation of any known channel of sensory communication; clairvoyance (sometimes called remote viewing), the apparent perception of objects or events that do not provide a stimulus to the known senses; psychokinesis, the apparent influence of thoughts or intentions on physical or biological processes; and precognition (conscious cognitive awareness) or premonition (affective apprehension) of a future event that could not otherwise be anticipated through any known inferential process - the anomalous retroactive influence of some future event on an individual's current responses*". This definition is in good correspondence with my term: EP, given earlier - with one extension. Daryl includes into his definition also precognition and premonition (I failed to confidently distinguish one from the other) - influence of future events on the subject's current state of consciousness. In the situation when there are absent reliable proofs of existence for narrower phenomenon: EP, study precognition - seems to me to violate the natural order of exploration. But, in any case, Daryl's experiments are interesting, and it would be instructive to investigate them. One of his experiments was dedicated to "precognitive detection of erotic stimuli". The following description of Daryl's setup is an abridged quotation from his paper.

"*On each trial of the experiment, pictures of two curtains will appear on the screen side by side. One of them has a picture behind it; the other has a blank wall behind it. Your task is to click on the curtain that you feel has the picture behind it. The curtain will then open, permitting you to see if you selected the correct. There will be 36 trials in all. Several of the pictures contain explicit erotic images. Each session of the experiment included both erotic and nonerotic pictures randomly intermixed, and the main psi hypothesis was that participants would be able to identify the position of the hidden erotic picture significantly more often than chance (50%).*

From the participants' point of view, this procedure appears to test for clairvoyance. That is, they were told that a picture was hidden behind one of the curtains and their challenge was to guess correctly which curtain concealed the picture. In fact, however, neither the picture itself nor its left/right position was determined until after the participant recorded his or her guess, making the procedure a test of detecting a future event, that is, a test of precognition.

Across all 100 sessions, participants correctly identified the future position of the erotic pictures significantly more frequently than the 50% hit rate expected by chance: 53.1%. In contrast, their hit rate on the nonerotic pictures did not differ significantly from chance: 49.8%. Because erotic and nonerotic trials were randomly interspersed in the trial sequence, this significant difference also serves to rule out the possibility that the significant hit rate on erotic pictures was an artifact of inadequate randomization of their left/right positions".

Let us remember: the duration of the session for each of the subjects was only 36 presentations of stimuli. Quite meaningfully sounds the last sentence of this quote - on the possible artifacts of inadequate randomization. What is striking - clearly insufficient number of stimuli presentations during each session. The researcher evidently decided to chase two... no, - four hares. Some sessions included pictures of erotic, neutral, just positive or negative content. Each type consisted of ridiculously small amount of pictures of each type: 18, or even 12. Daryl

even did not monitored the real behavior or RNGs on such short sequences. Below I will discuss this issue in more detail.

In what concerns explanation of results obtained, the author points out four possible explanations:

1. Precognition or retroactive influence: The participant is, in fact, accessing information yet to be determined in the future, implying that the direction of the causal arrow has been reversed.
2. Clairvoyance/remote viewing: The participant is accessing already-determined information in real time, information that is stored in the computer.
3. Psychokinesis: The participant is actually influencing the RNG's placements of the targets.
4. Artifactual correlation: The output from the RNG is inadequately randomized, containing patterns that fortuitously match participants' response biases. This produces a spurious correlation between the participant's guesses and the computer's placements of the target picture.

I think that the closest to reality and mostly determinative was the 4th alternative. It is very symptomatic that many researchers of EP always detect tiny confirmations of their hypotheses. It looks, at least, strange. For example, Daryl invited a hundred of subjects without serious preliminary testing of their EP-abilities. Receiving absolutely unconvincing success rate in favor of his hypothesis, he did not manage to choose the talented "shamans", witches or clairvoyants from them - in order to obtain much more persuasive rate, say, about 75-80% or even more instead of very modest 53.1%. It would efficiently and convincingly plugged the throat to the criticism of such sort.

This consideration so absorbed me that I stopped scrutinizing the subsequent experiments presented in this paper, and decided to see how different RNGs behave themselves in reality. From the very beginning I was under the spell of worshiping the "physical" RNG in comparison to software pseudo-RNG (PRNG) ersatz. One of the argument is that PRNG generates "not genuine", "not QM-based" deterministic algorithmic number sequence. Of course, the first thing that occurred to me - to use simple household tools. Coin tossing was outright rejected, due to the obvious effect of many anthropogenic factors influencing the process of getting a result. At last, the following RNGs were chosen for experimental investigation.

Spinning coin on a saucer (RNG1). It was done with the help of two fingers from the both hands. In the process of rotating coin was moving across the saucer surface and sometimes reflected from its rim before the fall. Heads were interpreted as 1, tails - as 0. I used 1 DM coin, 1982 y., 23.5 mm in diameter, 1.9 mm thick.

1. Throwing cubic die (RNG2). Die was a 15 mm cube of hard plastic, each face of which was marked with symbols from 1 to 6. Even characters matched odd ones on opposite faces. Die was placed in a plastic disposable cup, which was covered with hand on top and vigorously shaken several times. Then hand was withdrawn and mark on the upper face was observed. Odd marks were interpreted as 1, even - as 0. Expectation for such procedure should tend to value: 50% for each of the values: 0 and 1.

Throwing 3 cubic dice (RNG3). Three identical dice were placed in the same cup, shaken and upper faces of them were observed. Evaluation was done according to majoritarian principle: if the number of odd faces was more than even, it resulted in "1", otherwise it was interpreted as "0". Evidently, such method also should asymptotically tend to 50% for each result.

Digital timer [KENKO] (RNG4). A Quartz clock with LCD indicator, was switched to the timer mode. Taken into account was only the last digit from the indicator: hundredths of a second. Timer was started and at arbitrary moment of time its indication was manually stopped. The value of rightmost digit was read from the indicator. As

they were progressing at the speed: 100 per second, it was reasonable to expect equal probability of occurrence for odd (encoded: 1) and even (encoded: 0) digits. After that indication was released - until the need for next random digit reading.

PRNG (PRNG5). Software pseudo-random number generator = RANDBETWEEN (0, 1) from Open Office 3.2.1, giving the sequence of 1 and 0.

PRNG (Scorcher-PRNG). [Scorcher-PRNG] - convenient program for generation of pseudo-random number sequences.

But my investigation started rather traditionally - in the search of possible correlation between RNG and my conscious (subliminal(?)) decisions.

Experiment 1. Trying to Correlate Personal Evaluations with RNG Stimuli

I intentionally use here the term "correlate" instead of three possible alternatives by [Bem, 2011] pointed at earlier: precognition, clairvoyance or psychokinesis. At current level of our knowledge it would be splendid to find them, at least altogether, leaving their discrimination to further studies.

In the experiment was used RNG1 - coin spinning on the saucer. While the coin spun, I guessed one of possible outcomes: 0 or 1 (Fig. 7).

Statistical behavior of studied sequences was controlled using Cumulative Sliding Statistics (CSS):

$$CSS(F_n) = \frac{100}{n}\sum_{i=1}^{n} F_i \ (\%)$$

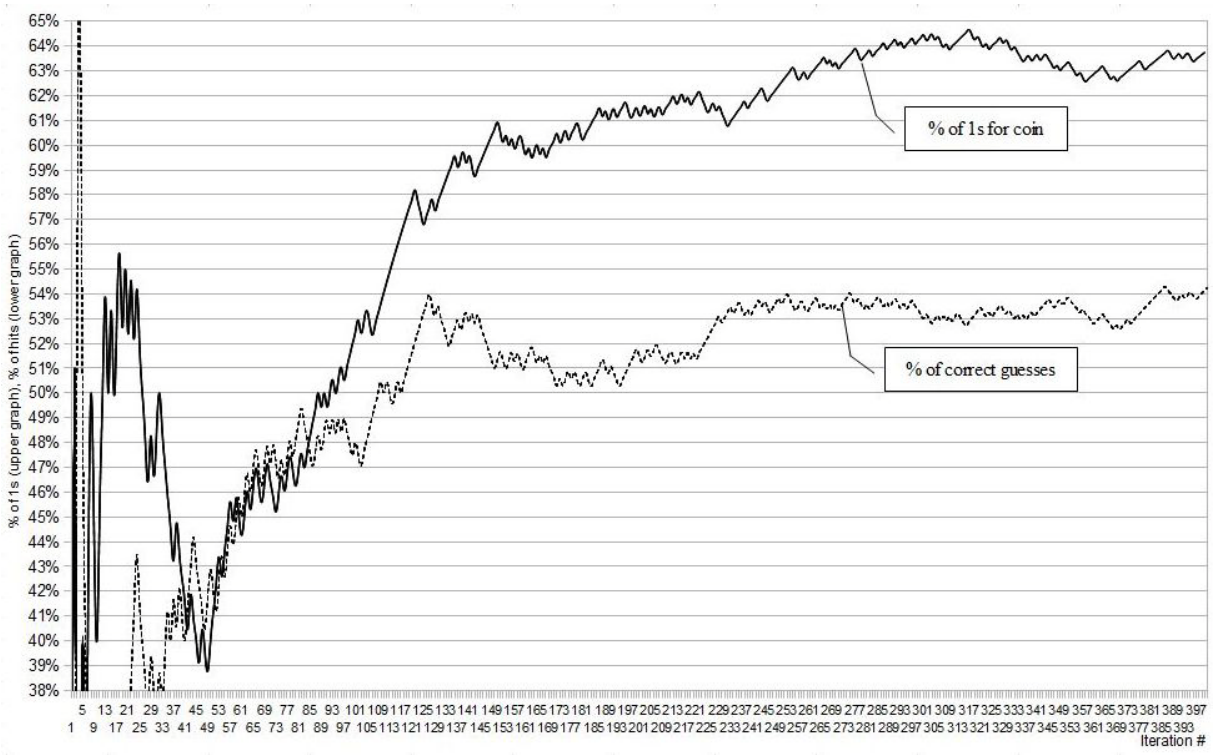


Fig. 7 Trying to correlate personal evaluations with RNG stimuli

The first thing to be mentioned is disgusting quality of RNG1: in the course of 400 iterations its CSS had evident tendency to approach the value 63.75% - instead of expected 50%. I think that probably the coin was a clipping from the cone - it made it more often fall on the same side. Although visually this defect was unnoticeable. The quality of my "correlative recognitions" was 54.25%. It is noticeably more than 53.1% reported by Daryl. Being absolutely no psychic myself, I "shown" evidently better results. Alas, due the defective RNG, they could have much more prosaic explanation.

A subject subconsciously adapts their responses to the statistics of stimuli presentations. Just imagine - presentation is the stable sequence of 1: 1, 1, 1, … Of course, the subject very soon will follow the same sequence, and its CSS would be very steeply approach 100% of correct guesses.

Experiment 2. Trying to Mirror RNG Behavior

This experiment was also based on RNG1. And there were no esotericism or mysticism involved at all. I just mechanically replicated the RNG reading, produced at previous step. It means that if RNG generates a continuous sequence of 0 or 1, the subject will effectively mechanically follow it improving the quality of correct guesses (Fig. 8).

Fig. 8 Guessing the face of spinned coin

As easily can be seen, CSS value of RNG1, as in previous experiment (63.75%), approaches the close value: 61.5%. It definitely indicates that RNG1 quality is unacceptable for delicate experiments with barely perceptible results in the vicinity of accuracy and reliability of measurements. The second outcome of this experiment is the CSS value for "guess" curve: it approaches here 53% - very close to Daryl's 53.1%.

Both experiments: 1 and 2 show very unstable CSS values for the initial RNG readings. They may present values: 39-55% (Fig. 7), 60-75% (Fig. 8) for sequences up to 60 iterations. Daryl in his experiments used 32 iterations.

That's why I stopped the further study of esoteric experimental results reported by [Bem, 2011] and turned to exploration of several other RNGs.

Exploring RNGs Behavior

As we have seen already, the quality of RNG has enormous influence on the results of experiments with "subtle energies" - Ganzfeld. Researchers should be very careful when they report their findings without the meticulous testing of their statistics. Let us take a look at Fig. 9, where are depicted the results of measuring CSS for four RNGs.

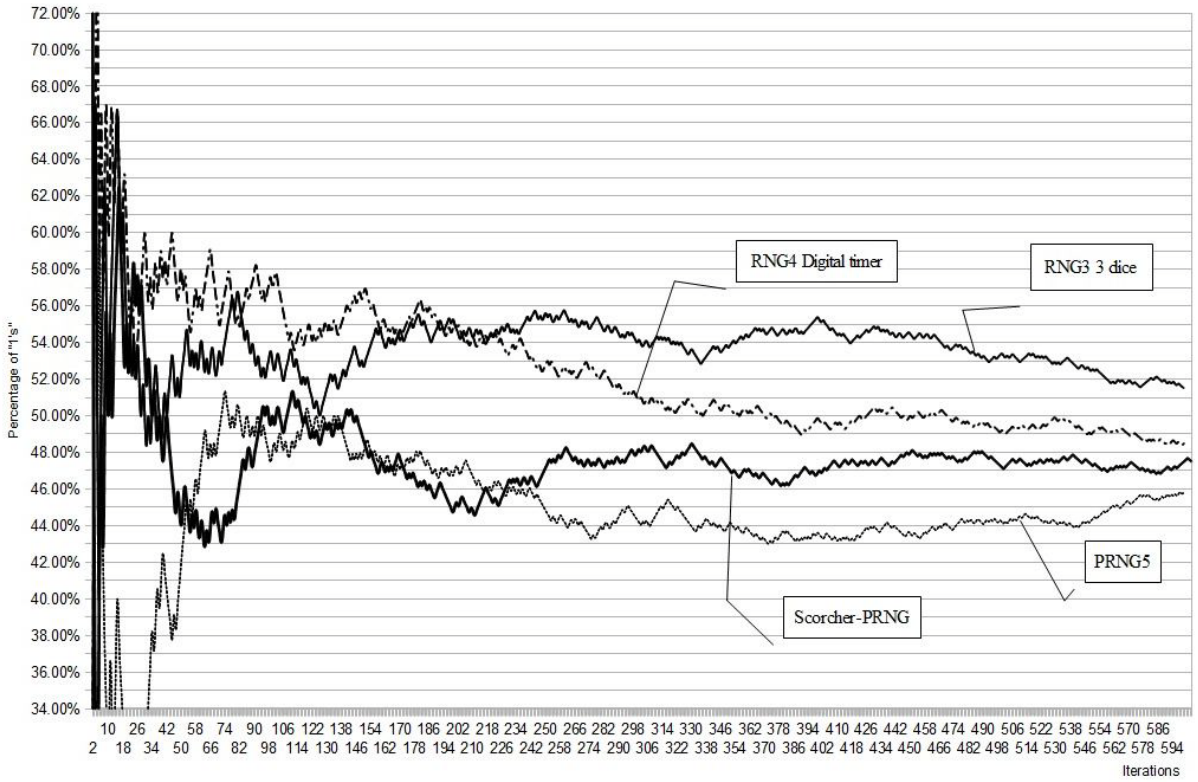


Fig. 9 CSS - Comparing four RNGs

Here is the table, which includes a sample of several CSS values for six experimental RNGs. Even sketchy evaluation of it and graphs on Fig. 9 brought me to the following conclusions.

RNG tested	**CSS (%) for 6 tested RNGs** averaged over a different number of iterations								
	36	**100**	**200**	**300**	**400**	**500**	**600**	**1000**	**10000**
RNG1 Spinning coin on a saucer	44	52	62	64	64	51	43		
RNG2 Throwing cubic die	64	52	52	52	52	51	50		
RNG3 Throwing 3 cubic dice	53	53	55	54	55	53	52		
RNG4 Digital timer	58	57	55	51	50	49	49		
PRNG5	58	42	48	50	48	49	50		
Scorcher-PRNG	38 - 58	50	45	48	47	47	48	49.6	50.32

Not apparent superiority of physical RNG over PRNG can be seen. There is no visible or philosophical advantages of random processes before pseudorandom. In addition, primary, and intermediate states of PRNG is easy to randomize. I do not think that there are objective methods, which would distinguish such sequence from the "natural" random.

1. It is senseless to evaluate any subtle effects on the basis of randomized experiments with number of iteration less than several hundred for two alternatives.
2. One should pay serious attention to the quality of random series, which is almost never done in "esoteric" experiments. It is not less important that in cryptographic applications. CSS is necessary but far not a sufficient indicator [NIST Test, 2010]. This conclusion parallels the opinion of Ray Hyman. "My analysis demonstrated that certain flaws, especially quality of randomization, did correlate with outcome. Successful outcomes correlated with inadequate methodology" [Hyman]. "In Hyman's view, 58% of the studies used inadequate randomization procedures" [Carroll].

Conclusion

If AI is going to simulate and enhance human ability of information processing, close attention should be paid to much broader spectrum of information handling aspects on the social and noospheric level. Science should not ignore evidences from its outsiders, including certain esoteric teachings. Physicists are already trying to develop theories of prospective fundamental information field, finding, as they suppose, some parallels between physics of microworld and ancient esoteric traditions. This problem naturally splits into two directions:

- working out physical background for "nonclassical" information exchange (esoteric phenomena: EP);
- studying available experimental evidences in support of EP, implementation of accurate and precise experimental tests of EP-phenomena.

In this regard, on the basis of the presented study can be made the following conclusions.

1. Unfortunately, the most authoritative and adopted by physicists quantum mechanics is very uncertain and contradictive in the issues of nonlocality, nonlocal interactions and information exchange. EP, as it can be understood from esoteric folklore, can be based only on nonclassical information exchange.
2. One should develop and implement reliable experimental setups for studying problems of entanglement and nonlocality. Among interesting phenomena is the problem of delayed choice quantum erasing.
3. In the paper was proposed experimental setup: RNG Double-slit, which presumably could help in answering some questions concerning wave-particle duality in the microworld.
4. Experimenting with EP detection and investigation requires RNG of very high quality. One should necessary and carefully test them before using in experiments according to several parameters, besides cumulative sliding statistics. Uncontrollably long sequences of identical figures should be avoided.
5. Number of iterations during EP experimenting should be sufficient for obtaining reliable results. For two stimuli it should be not less than several hundred.
6. Today became popular studies of EP where on the basis of theoretic statistic considerations are reported results with negligible effect. Such studies are very unconvincing. It would be instructive to choose best EP operators and try to achieve much more impressive figures, say: 70-90% (if the expectation is 50%).
7. Pseudo-RNG sometimes should be preferred for EP experimenting: their quality can exceed the quality of physical RNG.

Bibliography

[Aspect] Alain Aspect, Bell's inequality test: more ideal than ever, NATURE vol. 398 18 March 1999 doi:10.1038/18296 News and Views, http://www.nature.com/

[Bell] Bell's theorem, http://en.wikipedia.org/wiki/Bell%27s_theorem

[Bem, 2011] Daryl J. Bem Feeling the Future: Experimental Evidence for Anomalous Retroactive Influences on Cognition and Affect, Journal of Personality and Social Psychology, Vol 100(3), Mar 2011, 407-425

[Carroll] Robert T. Carroll, Meta-Analysis, Skeptic's Dictionary, 1994-2010, http://www.skepdic.com/metaanalysis.html

[Einstein et al, 1935] A. Einstein, B. Podolsky, and N. Rosen, Can Quantum-Mechanical Description of Physical Reality Be Considered Complete? Phys. Rev. 47, 777–780 (1935)

[Gorky] Максим Горький, Жизнь Клима Самгина, 1936, - popular phrase uttered by one episodic character - when looking for drowned Boris Varavka: "Really, whether there was a boy, maybe he was not?" Commonly used option: "Was there really a boy?" - "А был ли мальчик?" , http://lurkmore.ru/A_был_ли_мальчик%3F

[Hemmick] Hidden Variables and Nonlocality in Quantum Mechanics, Douglas L. Hemmick, ©1996 Rutgers U http://www.intercom.net/~tarababe/DissertPage.html

[Hyman] Ray Hyman, The Evidence for Psychic Functioning: Claims vs. Reality, Special Report, Ray Hyman, Skeptical Inquirer Archives, Volume 20.2, March / April 1996, http://www.csicop.org/si/show/evidence_for_psychic_functioning_claims_vs._reality/

[KENKO] Car clock KENKO KK-613D, http://urun.gittigidiyor.com/DIGITAL-MINI-SAAT-OTO-BUZDOLABI-MASA-VB-YERLERE_W0QQidZZ37042563

[Kim et.al, Rhodes, 2000] Excerpts from "A Delayed Choice Quantum Eraser" by Yoon-Ho Kim [1], R. Yu, S.P. Kulik, Y.H. Shih, and Marlon O. Scully, Phys.Rev.Lett. 84 1-5 (2000) - With commentary by Ross Rhodes, http://www.bottomlayer.com/bottom/kim-scully/kim-scully-web.htm

[Laszlo, 2003] Ervin Laszlo, The Connectivity Hypothesis. Foundations of an Integral Science of Quantum, Cosmos, Life and Consciousness, State University of New York Press, Albany, 2003, ISBN 0-7914-5785-0

[Laszlo, 2004] Ervin Laszlo, Science and the akashic field: an integral theory of everything, Inner Traditions Rochester, Vermont 05767, ISBN-13: 978-1-59477-181-1, 2004, 2007

[Lozovskiy, 2003] V.Lozovskiy, Towards the semiotics of Noosphere, International Journal "Information Theories & Applications", ISSN 1310-0513, Ed. in chief Krassimir Markov, 2003, Vol. 10, # 1, http://www.foibg.com/ijita/ijfv10.htm, p. 29-36

[Lozovskiy, 2006] Vitaliy Lozovskiy, Towards the Noosphere of Intangible (Esotericism from Materialistic Viewpoint), International Journal "Information Theories & Applications" (IJITA), ITHEA, ISSN 1310-0513, Vol. 13 / 2006, # 4 Ed. in chief Krassimir Markov (Bulgaria), p. 383-395, http://www.foibg.com/ijita/vol13/ijita-fv13.htm

[Lozovskiy, 2007a] Vitaliy Lozovskiy, Magic of Egregors, XIII International Conference, KDS-2007, June 17-25, 2007, Varna, Bulgaria, «Knowledge-Dialogue-Solution» Proceedings, Vol. 2, ITHEA, Sofia, 2007, p. 634-649, http://www.foibg.com/conf/ITA2007/KDS2007/KDS-2007-preliminary.htm

[Lozovskiy, 2007b] В.С.Лозовский, Где ты, Господи? - Первая международная научная конференция "Мистико-эзотерические движения в теории и практике (история, психология, философия)", сб. трудов, 15-17.09.07, Киев, Санкт-Петербург, 2008, ISBN 978-5-288-04789-3, 160 с. (стр. 29-40)

[Lozovskiy, 2008] В.С.Лозовский, Информационное поле: мистика или реальность?, Международная научная конференция "Биополевые взаимодействия и медицинские технологии" - Семинар "Слабые взаимодействия в живой природе" им. И.М.Когана – МГУ им. М.В.Ломоносова и МНТОРЭС им, А.С.Попова,, 16-18.04.08, М., Россия, стр. 11-15

[Lozovskiy, 2009] Vitaliy Lozovskiy, Consciousness: Magic, Psychology and Physics, International Book Series "INFORMATION SCIENCE & COMPUTING", Number 12: Human Aspects of Artificial Intelligence, Supplement to the International Journal "INFORMATION TECHNOLOGIES & KNOWLEDGE" Volume 3 / 2009, Sofia, Bulgaria, 2009, ISSN 1313-0455, p.106 – 115, http://www.foibg.com/ibs_isc/ibs-12/ibs-12.htm (http://www.foibg.com/ibs_isc/index.htm)

[Lozovskiy, 2010] В.Лозовский, Метафизика эзотерики, Международная научная конференция «Биоэнергоинформационные взаимодействия — единство и гармония мира» - Семинар "Слабые взаимодействия в живой природе" им. И.М.Когана – МГУ им. М.В.Ломоносова и МНТОРЭС им, А.С.Попова,, 15-16.04.10, М., Россия, стр. 12-17

[NIST Test, 2010] A Statistical Test Suite for the Validation of Random Number Generators and Pseudo Random Number Generators for Cryptographic Applications, NIST Special Publication 800-22rev1a (dated April 2010), http://csrc.nist.gov/groups/ST/toolkit/rng/documentation_software.html

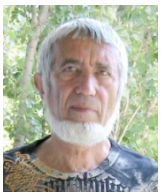
[Peres, Terno, 2004] Asher Peres, Daniel R. Terno, Quantum Information and Relativity Theory, Rev.Mod.Phys.76:93,2004, http://arxiv.org/abs/quant-ph/0212023v2

[Scorcher-PRNG] http://www.scorcher.ru/any/rand.zip

[Sheldrake, 2005] Rupert Sheldrake, Morphic Resonance and Morphic Fields. An Introduction, http://www.sheldrake.org/Articles&Papers/papers/morphic/morphic_intro.html, The Co-Intelligence Institute, http://www.co-intelligence.org/P-morphogeneticfields.html

[Wikipedia, Sheldrake] Rupert Sheldrake, http://en.wikipedia.org/wiki/Rupert_Sheldrake

Authors' Information



Vitaliy Lozovskiy *– Independent researcher, Odessa, Ukraine*

e-mail: vitaaliy@gmail.com, ICQ: 24389662, Skype: nikit_a, tel. +38 068 2611890 (cell)

Major Fields of Scientific Research*: philosophy, psychology, epistemology, esotericism, quantum mechanics, artificial intelligence*

The paper is published with financial support by the project ITHEA XXI of the Institute of Information Theories and Applications FOI ITHEA (www.ithea.org) and the Association of Developers and Users of Intelligent Systems ADUIS Ukraine (www.aduis.com.ua)

CONCEPTUAL KNOWLEDGE MODELING AND SYSTEMATIZATION ON THE BASIS OF NATURAL CLASSIFICATION

Mikhail Bondarenko, Nikolay Slipchenko, Kateryna Solovyova, Andrey Danilov, Ruslan Kovalchuk, Irina Shcurenko

Abstract: *Knowledge management is aimed at the sustainable development and competitiveness increasing of an organization, a state, a human. The appropriateness of knowledge application for solving a new class of complete ill-structured qualitative problems in weak-structured domains is noted, for example, of many problems in the social (organizational) systems, ecological systems; for the information society creation; creating and implementing new informational technologies; for improving the management and many others. To solve such problems is also needed a preliminary information-analytical phase, of taking into account the semantics of information and the application of new effective system methodology - systemology, which corresponds to the new noospheric stage of science development. The sections of this work are meaningfully combined, in the first place, by using the new method* ***of systemological classification analysis for the knowledge*** *systematization and conceptual models creation, taking into account the criteria of natural classification. The method of systemological classification analysis, for example, allows obtaining new deep knowledge and systematizing the knowledge in any domain the most adequately and objectively, taking into account the essential properties and relations. Using the systemological classification analysis allows evaluating any knowledge classification, to take into account the objects essential properties and relations; to predict the new objects on the base on their properties. New constructive criteria of natural classification allow creating "correct" classifications, which in all spheres of application ensure the effectiveness of solving problems. The examples of systemology and systemological classification analysis application are proposed for creating the domain ontological models - social networks, change management, human needs, directly related to knowledge management, as well as during the development the online store products and services catalog. When using systemology in change management, the organizations can obtain weighty benefits. The application of systemological classification analysis in social networks allows increasing the effectiveness of their functioning based on the use of knowledge systematization (through the development of an effective system of functions and menus). All this will help the company to increase significantly its intellectual capital without using large investments.*

Keywords*: knowledge systematization, natural classification, ontology, systemological classification analysis, conceptual knowledge, conceptual modeling, deep knowledge, knowledge management, social network in Internet, change management, hierarchy, systemology, artificial intelligence, Protégé, context diagram.*

ACM Classification Keywords*: 1.2 Artificial Intelligence – 1.2.6 Learning: Knowledge Acquisition*

Introduction

One of the most effective instruments of the society sustainable development, of the governance effectiveness and the organizations competitiveness increasing is knowledge management (KM). Using of the knowledge management methods and models opens many new solutions of improving competitiveness, developing

intellectual, social and personal capital. Modern successful companies have long understood that it is knowledge - the main competitive advantage, that is why their intellectual capital at a cost is tens or hundreds of times greater than the material one. Knowledge is needed to solve a new class of complex non-formalized qualitative problems in weak-structured domains, for example, many problems in the social (organizational), environmental systems, for the information society creating; for the human survival; for innovative information technologies development and implementation and many others.

Solving such tasks requires the mandatory pre-information-analytical phase, which role is constantly growing, taking into account the semantics of information and the application of the new system methodology - systemology [Бондаренко и др., 1988], which corresponds to the new noospheric stage of science development, has a high efficiency and capacity in solving complex modern scientific and practical problems on the basis of knowledge.

The work of the analyst (knowledge engineer) is appropriate and necessary for the successful implementation of the processes of informatization, automation and complex software products development. Without the prior analysis these processes can become a "disorder" automation, the software will not meet the customer's requirements, and the number of unnecessary documents during workflow automation will increase. Some ideas, similar to systemological ones, are intuitively used (for example, in the requirements engineering), but the systemological methods [Бондаренко и др., 2004], [Соловьева, 1999, Bondarenko et al., 2006] are more reasonable, constructive and effective.

The method of the systemological classification analysis (SCA) [Соловьева, 1999, Solovyova, 1991, Solovyova, 2000], for example, for the first time allows to obtain new deep knowledge and to systematize knowledge in any domains the most adequately and objectively, taking into account the essential properties and relations. Using of SCA allows evaluating the validity of any knowledge classification, the reflection in it of the objects essential properties; predicting new objects based on their properties. New constructive systemological criteria of natural classification (NC) [Соловьева, 1999, Solovyova, 1991, Solovyova, 2000] allow creating the most "correct" classifications, which provide successful theoretical and practical results in all spheres of their application: the effectiveness of solving problems, further development of domains, openness, extensibility of models; further automation, convenience of users. For example: the definition of emergency measures applied in emergency situations, quick and efficient search of products and services in online stores; business modeling [Bondarenko et al., 2006], the definition of mission and strategy of the organization, the intellectual capital analysis and evaluation; the effective menus in the software system interfaces, the powerful ontologies and the knowledge systematization in KM systems. Thus, the application of the functional requirements of to the software systemological classification allows getting full, sufficient and mutually agreed requirements, that may significantly reduce the project time and budget in case of using a specially designed systemological language of modeling requirements in the form of UML-profile [Vanhoof et al., 2009]. The SCA application in social networks (SN) helps to develop an effective functions system, to improve their functioning [Данилов, 2010].

In this paper are briefly considered some examples of Systemology application, primarily, of the systemological classification analysis application, in the domains - social networks, change management, directly related to KM, as well as during the online store products catalog development.

Systemological Method of Conceptual Modeling of an Arbitrary Problem Domain on the Basis of the Natural Classification

The Natural Classification importance, peculiarities and criteria [Соловьева, 1999, Solovyova, 1991, Solovyova, 2000] have been considered earlier, including - briefly - in [Bondarenko et al., 2010].

Let us consider the unique innovative method with the help of which conceptual modeling of a domain on the basis of the natural classification may be realized.

Nowadays the need to solve complex low-formalized problems in different areas of human activity has considerably increased. To such areas refer, for example, sustainable development of the society which becomes more and more problematic in connection with the strengthening of the man's influence on the environment, caused by the increase of the scale and intensity of the economic activity in current conditions. This circumstance makes it necessary to develop methods of analysis and modeling of complex systems of an arbitrary, including natural (first) nature, for which, as a rule, are not known their role in the higher order system (supersystem), functional purpose (objective function), and consequently, their essential properties.

To solve such problems the new systemological cognitive method of conceptual classification modeling of arbitrary, including weak-structured, domains is designed and is developing. From a practical viewpoint, this has ensured the creation of **the systemological classification analysis** which uses the method of conceptual modeling of low-structured domains on the basis of the natural classification.

The CM on the basis of the NC became possible not only resulting from the determination of the basic NC regularities and criteria, but also resulting from the creation of a new scientific direction – systems-classes systemology. From the viewpoint of systemology a great importance for the CM has the definition of the researched system supersystem and of the functional query to the system, that is the causes of the system appearance and objective function [Мельников, 1986, Маторин, 1998, Бондаренко и др., 1998].

In the terms listed in Supplement A systemology application to CM involves the system analysis from the viewpoint of the definition:

- of the supersystem query on the given system with the defined function (of the external determinant);
- of the process of transformation from potentially suitable for the formation of this system initial material to the system as an element (substance) of the corresponding supersystem, that is of the process of the given system establishment and its adaptation to the supersystem query;
- of the given system function in the supersystem corresponding to the supersystem query (of the internal determinant).

The results of such an analysis provide the knowledge acquisition, respectively about the cause and about the conditions of the system appearance with certain properties, about the dynamics of this system establishment process, as well as about the consequence of its appearance and functioning. If the system appearance cause in some domain can be determined by its own specific means, it facilitates the determinant analysis.

The obtained results and many years of experience in classifications creation allowed developing and improving the well-known KM methods, above all on the basis of the EC regularities and of the CM methods application of the systemological analysis accounting. Nowadays it is proposed the following method of systemic classification analysis [NC] for the constructing of the conceptual classification model (CCM) of an arbitrary domain based on the NC taking into account the NC operational criteria of and the determinant approach to the domain analysis

which complements the existing CM methods with the ways of determining the objects essential properties and taking into account the deep knowledge about the domain. Let's consider the iterative structure of this method (Figure 1).

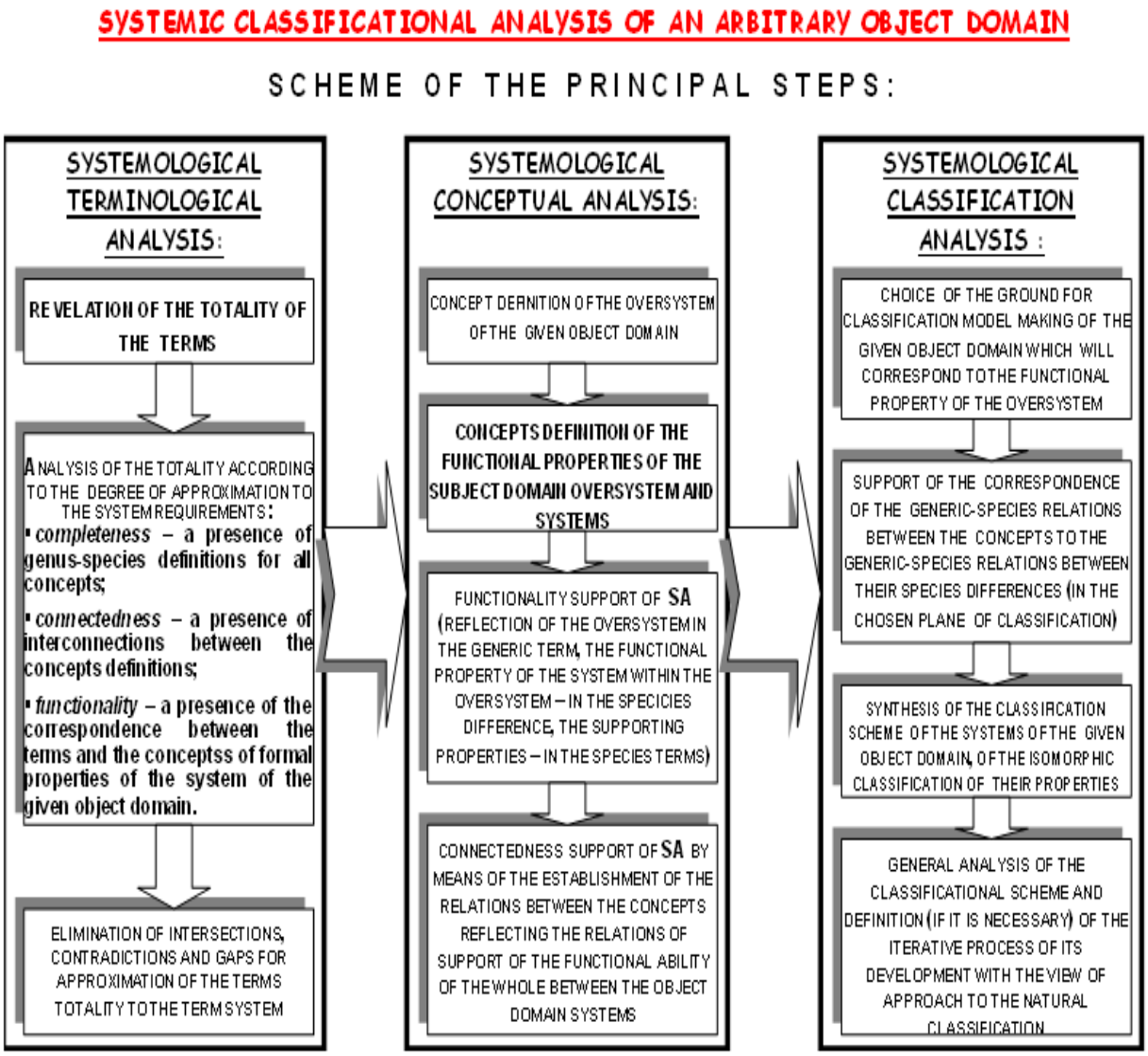


Figure 1. Systemological Classificational Analysis of an arbitrary object domain

1. Domain systemological terminological analysis.

Detection of the set of terms denoting objects and processes of the given domain that is of the terms for the concepts describing the given domain (categorical, general and single).

Analysis of the identified initial set of terms in order to determine the degree of its approximation to the system of terms by the indicators of completeness, connectivity and functionality of **ST**, corresponding to the initial set of the terms:

- analysis of the genus-species definitions availability for all concepts, corresponding to the selected set of terms (species, genus and species differences concepts);

- analysis of the interrelatedness degree of the considered concepts;

- revelation in the original set of terms such terms which correspond to the concepts reflecting the functional properties of the given domain systems (from the viewpoint of the revealed categorical concepts).

Removal of intersections, contradictions and gaps in the considered set of terms, that is its maximum possible optimization (approximation to the system of terms).

2. Domain systemological conceptual analysis.

The given domain place (role) determination in the broader domain, that is the determination of the supersystem (or the supersystems) of the given domain and of the corresponded to it undeterminable concept (or concepts) (of the singular category or several categories taking into account several aspects of the given domain consideration).

Determination of the given domain functional properties, essential from the viewpoint of each selected supersystem (category).

Functionality of the given domain ensuring, that is reflection of the given domain systems revelated functional properties (in a genus concept – of the given system supersystem, in a species difference – of the functional property of the given system in the supersystem, in species concepts – of the system supporting properties) in all the concepts definitions.

The concepts system connectivity ensuring by hierarchical genus-species relationships establishing between the given domain concepts reflecting the relationship of the whole functional ability support between the given domain systems.

3. Domain systemological classification analysis.

The grounds of the given domain classification model (scheme) constructing choice (corresponding to the revealed functional sign of the given domain systems from the viewpoint of the determined supersystem for the given domain).

Ensuring of the genus – species relationships correspondence between the given domain concepts and their species differences in the chosen classification plane. The given domain systems hierarchical classification construction, their properties isomorphic classification construction (in the given classification plane).

During this method implementation in the first stage the initial material satisfying the naturalness operational criteria of systemic and properties for the classification model construction is being prepared (p. 6.5). At the second stage the monism and hierarchy criteria execution on the selected initial material is provided (p. 6.5). At the third stage the classification scheme parametricity is provided that with the hierarchy condition observance provides its naturalness (p. 8.5). It is obviously that for ill-structured and low-formalized domains this method application will represent an iterative process. However, its (the method) usage arms the human analyzing and modeling the domain with a more profound understanding of the given domain structure because it facilitates the process of its definition. To some extent, the process stays heuristic, but within a formalized (but not formal) procedure.

The considered method use allows, in particular, to evaluate each classification from the viewpoint of its validity (parametricity), reflection of the objects essential properties in it, the possibility of the objects properties detection and prediction according to their place in the classification, that is from the viewpoint of the possibility of the classification application as a tool for theoretical (and practical) analysis in the correspondent domain.

Creation of the Classification Fragment of Organizational Change

To analyze the domain of organizational change suggest using systemological approach and method systemological classification analysis. Systemology considers objects around us, events, etc., as a system, supersystem and subsystems. Moreover, we can understand that the system has a supporting property that allows the supersystem functioning. It is assumed that "system is a functional object or a function, i.e. has the ability to perceive the impact of certain environmental or supersystem and in response to issue necessary for the supersystem results of their actions, that is, in fact, be the cause of the transformation of certain actions in certain desired results" [Bondarenko et al, 1998]. Therefore, we can draw an analogy with the process of doing business. The organization is a system that has a function to meet the needs of a supersystem (needs of customers). But there are times when the functional query can be changed and the system cannot perform supporting function.

There are three types of properties that the system has [Bondarenko et al, 1998]: shown, hidden and potential (deep) [Bondarenko et al, 1998]. When the organization meets the customer's needs - it has some shown properties. But in case of change of the functional request, the system is not able to accomplish supporting functions. In this case, the organization must adapt or evolve during the development of its hidden and potential properties.

This problem can be solved by using a change management. Change management process provides an opportunity to properly assess the current situation in the organization, to identify its weaknesses, to predict what the company can achieve in the future, in case of change of any conditions of work in the organization. Managing change is a very complex process that requires some training of the person responsible for it. The choice of approach to the management changes may impact on the fortunes of the company. There are many methods, strategies, models describing the phased plan for change. Each of these methods has its advantages and disadvantages. But before examine these methods; it is useful to know what the organizational changes there.

Analysis of the domain showed that there was no built structured parametric classification before. No classification, which would be built with a view of the essential properties. Such a classification would help the user to understand the areas in which changes can be made and what objects in the organization, they may affect.

In constructing the classification was chosen supersystem - Changes. The basis of division of domain concepts is the object changes. The fragment of the classification of organizational change was built (Figure 2, Figure 3).

*During the classification creation were used the materials of such electronic resources: http://courseware.finntrack.eu/learners/organisation_dev_change.html - Organisation Development and Change; http://www.e-college.ru/xbooks/xbook031/book/index/index.html?go=part-016*page.htm - Organizational dynamics: dysfunctions and organizational changes; http://www.westbrookstevens.com/ Types_of_Change.htm – Types of Change.*

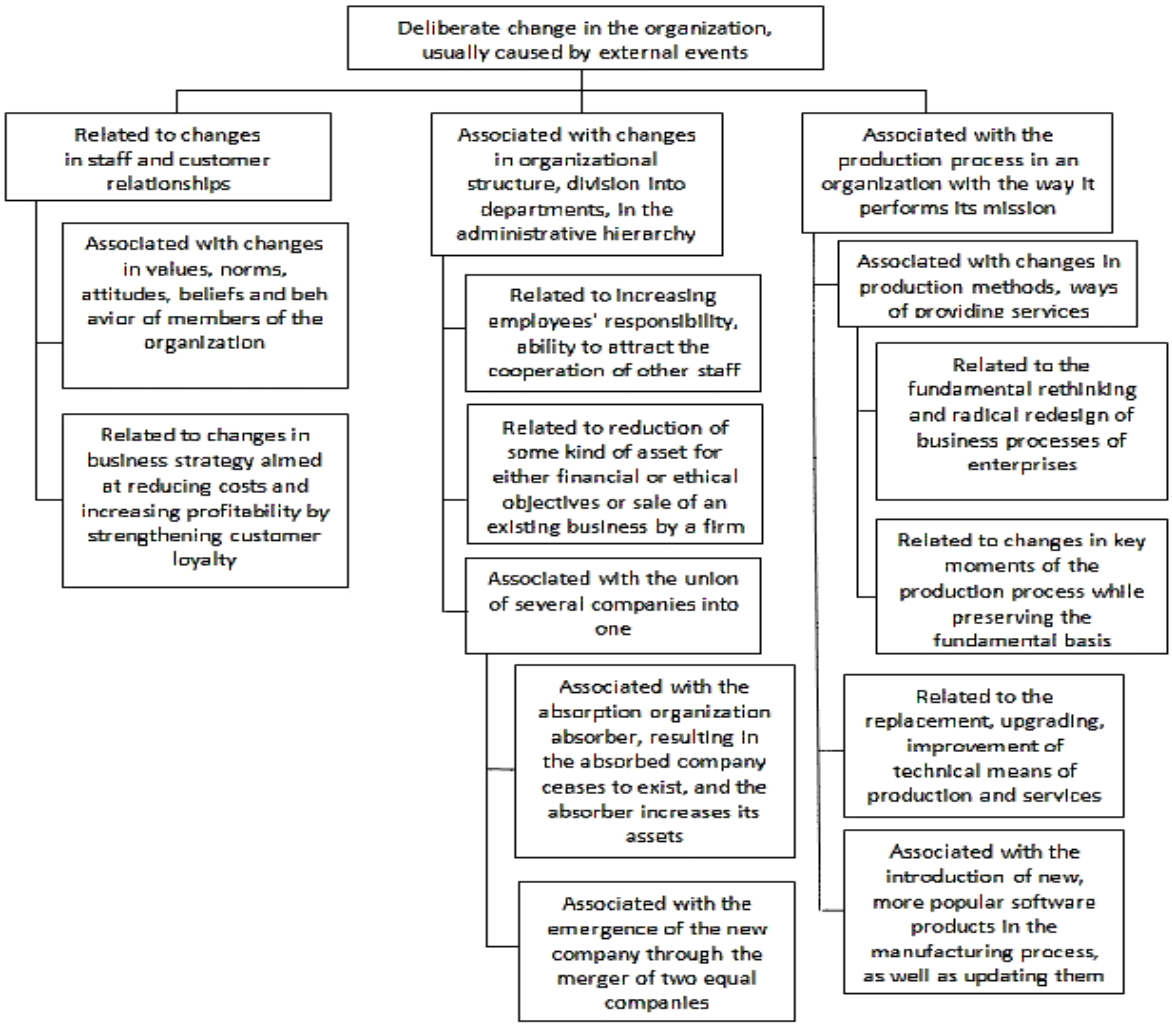


Figure 2. Classification fragment of properties of organizational change

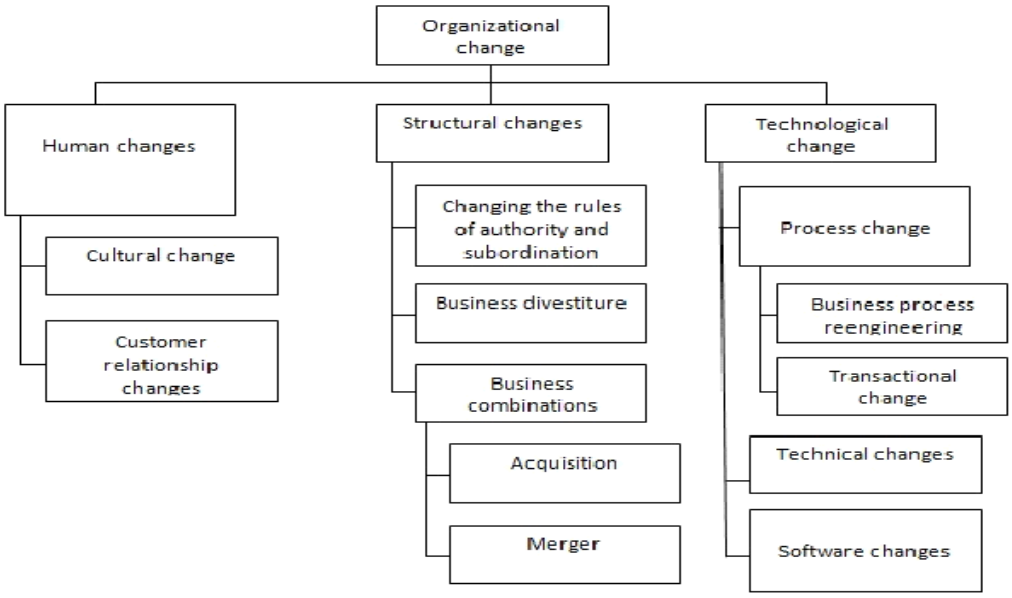


Figure 3. Classification fragment of organizational change

The Fragment Creation and Realization of Classification of "Human Needs"

Work is devoted to the subject area "human needs" research and modeling. To study this subject area was used systemological classification analysis method which allows determining the nature of the subject area, as well as its basic concepts and their properties, and relations between them.

Any subject area should be viewed not as a simple sum of the components, as well as a set of nonlinear and multi-interacting objects, as the whole system. The system has the support properties, which helps operate the supersystem.

Needs – a system that performs some functions that can satisfy the demands of supersystem. Supersystem for system of the needs is people. During his lifetime he has needs in conditions of life, in items and things, without which it is impossible to exist and develop. All the conscious and unconscious human activity aimed at meeting the needs that is to receive something which necessary for a fulfilling life. It is this "something" lends purposefulness to human promptings, and for their motivation lends sense. Meet the needs helps the system (a person) to functionate. Then the basis of division for the construction of classification we must select functionality.

The process of constructing the classification consists of several stages. In this case, all stages are carried out not sequentially, but depending on the completeness and accuracy of accumulated data.

The difficulties arise already at the first attempt to classify, as the needs of diverse and highly variable. They depend on the particular individual. Therefore, in this classification are only the most common needs that are inherent in every person. All human needs can be divided into those that provide its material existence (material) and those without that a person could exist, but it will not feel happy, satisfied. This is non-material needs. They are related to emotional state. Both material and immaterial needs are closely related, but nevertheless, their properties are different. To ensure the people's material existence is necessary, first of all, such things as food, water, air, clothing, shelter, etc. These concepts were divided into those requirements, which are due to human physiology, that is, without them his body can not functionate (they are innate), and those which are necessary to maintain the body in a healthy condition.

Non-material needs have been divided into those whose satisfaction is necessary for a person's internal development, and those that arise from the need to live in society.

Constructed a classification of properties displayed in Figure 4.

Objects in this classification has been systematized according to the classification of their properties (Figure 5), that is, for each component of the classification has generic features and also a concept that is specific difference in the content of the concept, which is classified. This allows to determinate accurately of all concepts in the classification of the recorded elements and connections through a generic term and concept of the specific difference.

The proposed classification can be refined depending on the specific problem to be solved and changes in our knowledge of the subject area.

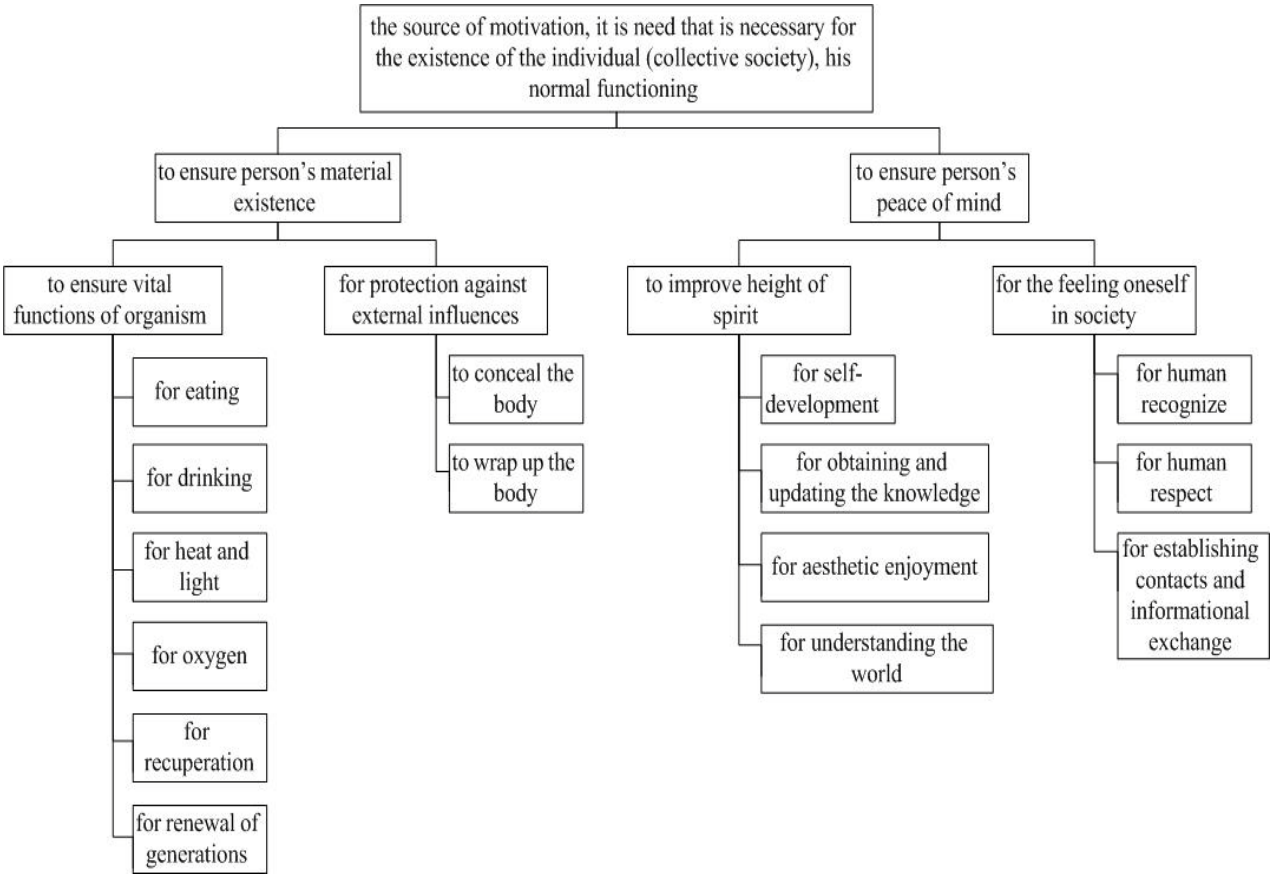


Figure 4. Classification of the properties of human needs by functionality

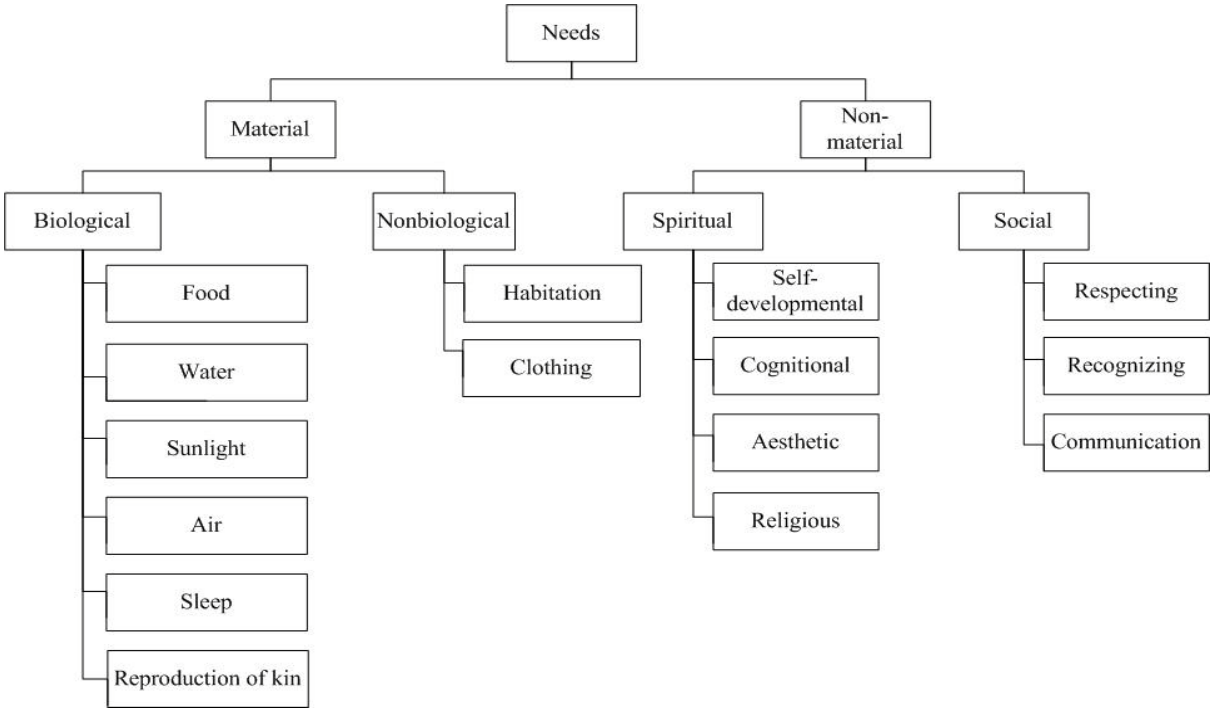


Figure 5. Classification of human needs by functionality

To construct this classification none of the existing has not been taken as a basis, location of each domain concepts was determined in terms of its basic properties. In the course of this work was an attempt to develop a classification domain model for "human needs". Supersystem - the person, the foundation of the division - the functionality.

It was compiled and analyzed a list of domain concepts. Terminology has been clarified, were built subsumtion definitions of basic concepts and defined the relationship between them. In addition to the classification of the concepts was build a classification of properties.

Constructed classification is not complete and final, since human needs are unlimited and depend on the particular individual.

Catalog Online Store as an Example of Practical Application

Today, in the era of global dissemination of information technologies and Internet services popularization, it is difficult to imagine our life without a computer, a phone and the possibilities which these devices provide to the users. One such possibilities can be a purchase of various goods and services via the Internet through online stores.

The main interface and means of getting the information about the proposed product is a catalog of an Internet store. That's why the reasonableness and the correctness of the products catalog composition, its adequacy to the domain are very important. The success of the store itself depends on the quality of the catalog. That's why the catalog has to be maximally (to what extend it is possible), convenient, informative and has to provide a quick search.

To solve this problem can Systemology and proposed by this science methods and tools of the weak-structured domains analysis and research.

In fact, the catalog - is a well-structured products classification. Therefore, during the catalog development it is appropriate to use the method of systemological classification analysis allowing to reveal the system essential property (in the given case, of the products system (and of their species-subsystems), sold in an online store), to determine the researched systems supersystems, to identify the functional queries and, based on them, to systematize the products. It will make the catalog use more convenient, will increase the speed and the efficiency of the search through the catalog. As an example, one can consider the proposed for the research the auto parts catalog fragment, already used by the search system in the online store (Table 1).

Table 1 – Auto parts catalog fragment

Auto parts
Auto chemicals
Storage batteries
Exhaust System
Engine
Isolation
Injector
Car Body
Washer
Plastic

Suspension
Shock absorbers
Alloy wheels
Forged
Alloy (cast)
Steel (stamped)
Others
Springs
Others
Drive

Steering
Salon
Glass
Fuel system
Braking system
Transmission
Headlights
Filters
Navigation
Others

An average user of this classification (catalog) will have difficulties to find the product interesting for him, since it can not know in what section this product may be located, what for these *auto parts* can be used, etc. (not all customers may know what for these or those auto parts are used).

In case of selecting a certain species of *auto parts*, the user may not find the detail necessary for him among the variety of the proposed items of the selected product species (of single concepts). For example, the user selects such an item of the catalog as *filters*, as a result, a variety of concrete *filters* species will be proposed to him (perhaps, hundreds). A user simply can not find the product necessary for him among the proposed variants.

To solve this problem it is necessary to make the further deeper concepts systematization - concepts distribution by the species taking into account their properties, i.e. the parametric classification creation by the functional destination, taking into account the naturalness criteria. The proposed operation will allow reducing in dozens of times the number of displayed items, which will be issued on the user's request. This will reduce the probability that the user will not be able to find the product necessary for him. It can also improve the usability and the speed of products search.

In the *auto parts* classification one can also trace the division concepts rules violation, a wrong division bases change, which is not allowed even by the formal logic criteria and which violates the main systemological relation of **the whole functional capability support.**

Due to the non-parametric character of the old catalog (the objects-classes properties absence in it), it is difficult to determine by which division base the division is made, and whether the chosen location of the concepts in the classification (whether they correspond to the domain) is right, without knowing the correspondent to them objects (divisible concepts) properties.

As the practice shows, the correct classification should be:

-convenient for the user, consequently – to correspond maximally to the domain structure and semantics;

- to ensure the successful search of the product (of the service), i.e. the user should easily find a product if it is in the catalog, to maximally increase and facilitate the product search;

- to be expandable (adding new products and services) and convenient to support.

Besides, a good classification can be the basis for automating many additional functions that are useful both for the user and for the online store owner.

From the scientific viewpoint, the correct classification (systematics) should adequately reflect the simulated domain, correspond to the formal-logical requirements (for example, the division base should not be changed) and to the systemological criteria.

Tables 2 and 3 show the *auto parts* catalog fragment, taking into account the concepts (products) properties which form the basis of the parametric classification. During creating this classification were used the materials of the site: http://expert.autocom.kiev.ua/kbase/c36 – Knowledge base for auto mechanists.

Tables 2 – Fragment of the developed auto parts catalog.

Auto parts			
	Power unit parts		
	Power system parts		
	Chassis parts		
		Bearing system auto parts	
			Car body
			Frame
		Wheel parts	
			Discs
			Buses
		Suspension	
			Dependent
			Independent
		Steering	
			Automotive
			Combine
			Tractor
		Braking system	
			Auxiliary
			Spare
			Working
			Marking
	Electrical Parts		

Table 3 – Properties of the concepts included to the auto parts catalog.

Auto parts			
	Designed to transfer engine torque to the wheels (working bodies) changes in traction, speed and direction of movement		
	Designed for storage, cleaning and fuel supply, air cleaning, cooking fuel mixture and feed it into the engine cylinders		
	Designed to move the car along the road linking the wheel to the body, damping the car.		
		Which are used for setting and fixing of all car parts	
			Designed to accommodate passengers and cargo
			For fixing the body and aggregates
		Allowing to put on their body roll and not slide	

			Serving to connect to a car tire with hub
			Designed to absorb minor fluctuations caused by imperfections in the road surface, error compensation paths wheels, implementation, and the perception of forces generated in the contact area and provide a high coefficient of friction
		Which connect the wheel to the car and allow them to move in a given direction, rotate, repeat the profile of the road	
			Designed for mounting the wheels on one axle, which is rigidly linked
			Designed for mounting wheels on one axle, without hard link
		Which are designed to provide the vehicle driver in a given direction	
			Designed to propel the vehicle driver in a given direction
			Designed for the movement of the combine in a given direction of a driver
			Designed or the propulsion of the tractor driver in a given direction
		Which are designed to reduce speed and / or stop the vehicle. They also help keep the vehicle from the spontaneous movements during a stop	
			Serving for long maintain a constant speed (downhill) at the expense of engine braking
			Serving to stop the vehicle at a failure of braking system
			Serving to regulate the speed of the vehicle and stop it
			Serving to keep the vehicle stationary on the road (parked), and also to prevent the vehicle rolling backward when starting on the rise
	Designed for the generation, transmission and consumption of electricity in a car		

The developed domain ontology, realized in Protégé 3.2, is not included to the given work due to its large size.

The systemological method of classification developing application, based on the natural classification, allows eliminating defects and ensuring the classification development and its operation in the automated system, increasing the search speed of the needed product by the user and the catalog usability.

The obtained classification is the solid basis of the online store catalog, for the users' convenience to this catalog can also be added other semantic relations, including – associations, resulting from the marketing and analytical research, Data Mining methods application. Such a classification will also be a useful base of various support automation systems and of the catalog functioning development and the online store competitiveness increasing.

Let us consider one more classification fragment – the domain "Business", the agriculture classification. The existing classification is represented in Figure 6.

164	43	Agriculture
165	44	Animal husbandry
166	45	Grain
167	46	Feed
168	47	Equipment
169	48	Vegetables
170	49	Seedlings and seeds
171	50	Garden equipment
172	51	Fertilizers
173	52	Fruits and berries
174	53	Others

Figure 6. Agriculture species catalog fragment

The proposed agriculture classification fragment contains 10 concepts: animal husbandry (44), corn (45), feed (46), equipment (47), vegetables (48), seedling and seeds (49), garden equipment (50), fertilizers (51), fruits and berries (52), others (53). The given concepts distribution contradicts to the division rules: the concepts are related to the inappropriate hierarchy levels (for example, vegetables, fruits and berries can not be on the same level with the animal husbandry; it is necessary to distinguish a class of plant breeding, to which to relate the listed concepts), the division base changes (by the definition, the agriculture is one of the industries engaged in the cultivation of crops and rearing of farm animals; that is, if one construct the classification by the functional destination, the equipment can not be part of the considered class in any case). Also, it is not needed to distinguish the class "others" as this will only complicate the search of the needed product species in the catalog by the user. The proposed classification fragment does not disclose fully the domain particularities because of the insufficient number of concepts listed in it.

Let's try to build our classification fragment taking into account the formal-logical and systemological classifying criteria..

The classification should provide the objects systematization by the defined chosen attribute which is the main for solving the stated task. In this case, the business is best divided by the destination, as namely the destination is that distinguishing attribute of the products and services, on which the catalog user primarily draws the attention. To create the correct classification will shall keep the same division base.

The place of each domain concept was determined on the basis of its essential property. The concepts properties are presented in Fig. 7. The concepts taken from the proposed classification are shown in italics (Fig. 8). The classification "Agriculture" was realized in the software tool Protégé 3.2 is shown in Figure 9.

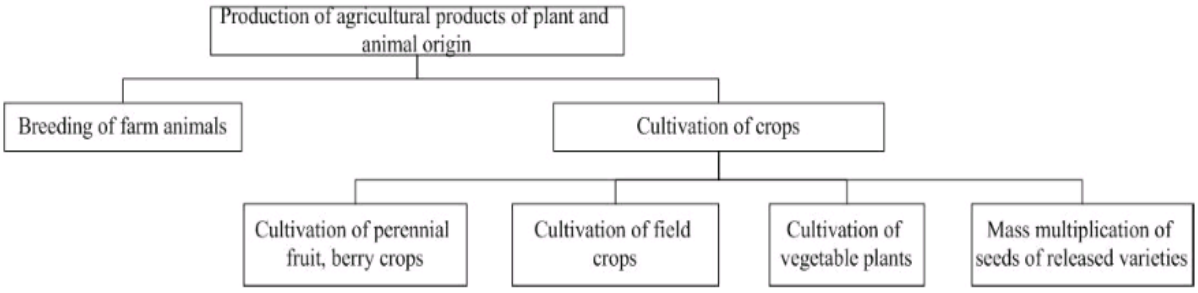


Figure 7. Properties classification

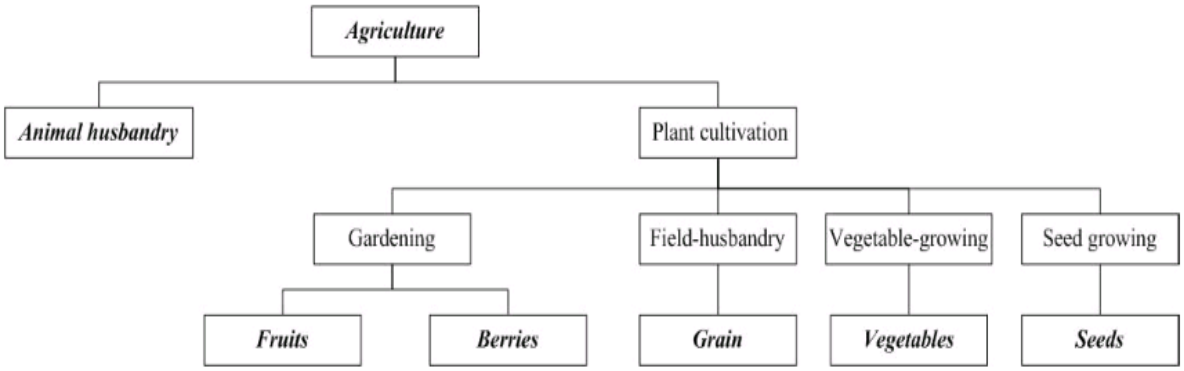


Figure 8. Concepts classification

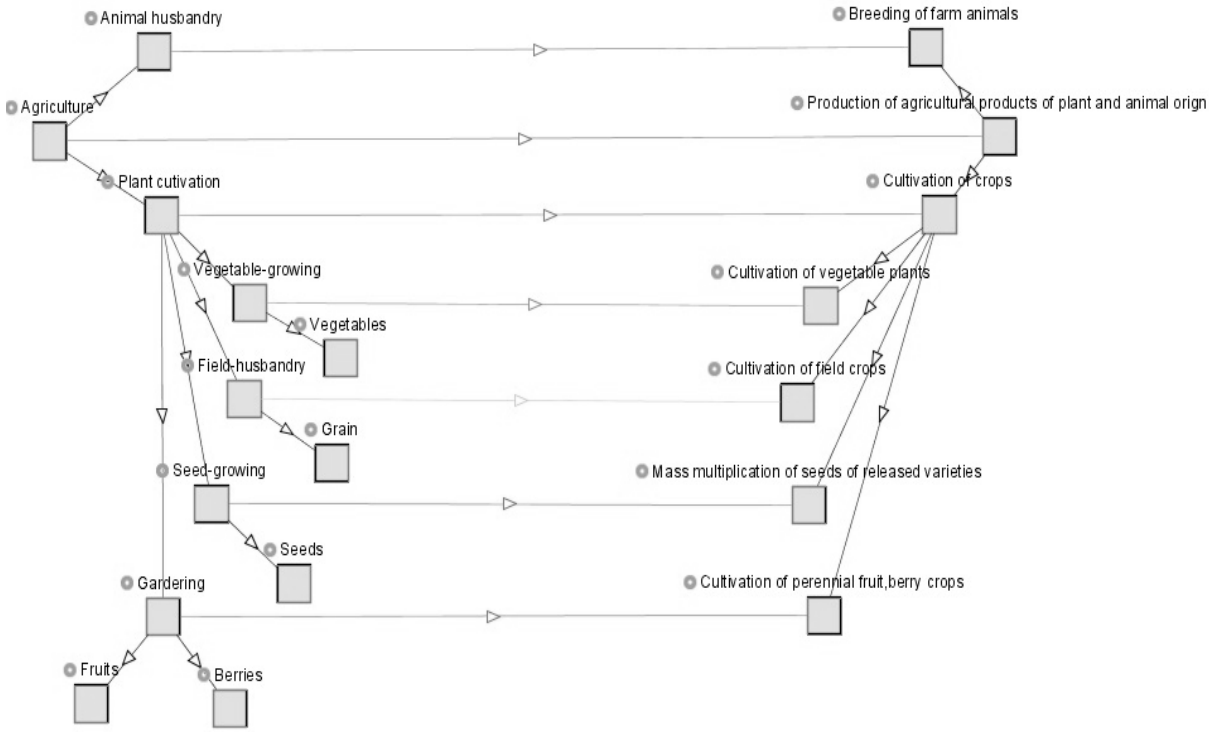


Figure 9. Classification "Agriculture"

During creating the agriculture species classification of the domain - "Business" have been used the materials of such electronic sources: http://ru.wikipedia.org/wiki/Сельское хозяйство - Сельское хозяйство; http://bse.sci-lib.com – Большая Советская Энциклопедия.

SCA Application in Social Networks as an Element of Knowledge Management

1. Analysis of Social Networks Use in Knowledge Management.

Despite the widespread of social networks in Internet, the models of knowledge dissemination in an organization by means of social networks sites have not been found. There is a number of articles describing the use of social networks for the social capital creating and using but there are no models of social networks implementation in an organization for knowledge dissemination and the employees' intellectual capital enhancing.

The model creation of knowledge implementation and dissemination in an organization will allow solving such important practical tasks as the social networks implementation process acceleration, improving their functioning effectiveness and facilitating the process of knowledge acquisition and dissemination in the social network space by the employees.

Recent publications and research in social networks domain reflect a widespread of social networks among Internet users. Increasing the role of social networks in the society life has led to the need of social networks implementation in the organizations life for supporting and increasing their competitiveness.

For more effective use of social networks it is necessary to understand which functions provide the social networks. In the previous publications the analysis of the concept "social network" has been accomplished, the existing functions of the most popular social networks have been analyzed and, based on the obtained analysis results, the recommendations for improving the functioning of the considered networks have been developed, the social networks functions classification has been created [Данилов, 2010].

The recommended informative placement of the functions of the first level of the hierarchy, taking into account the systemological classification analysis use and the natural classification criteria, is shown in Figure 10. The functions placement is understood as their placement in the networks workspace. The informative placement is understood as the functions structure their hierarchy in the social network menu. Our informative placement displays the functions relationship taking into account the knowledge systematization and the relations semantics between them in the best possible way.

Resulting from the analysis it was proposed to divide all the functions of the first level of the hierarchy on such groups: user information, my data, my messages, search and the function of input/output from the network workspace. Such functions placement will allow reducing the load on the user and speeding up the process of the needed function search, as it reflects the functioning of the whole support ability relation.

The substantial functions placement in the social networks proposed, as the result of the conducted functions system analysis, will facilitate the functions search for the social network new users, will reduce the sense loading on the user when working with the network, by reducing the number of functions on the same level of the hierarchy.

To facilitate the work with social networks and for the further study of the social networks domain the social networks functions classification with the division base by functional purpose has been created.

The conducted research shows the necessity of the further study and knowledge systematization in the social networks domain.

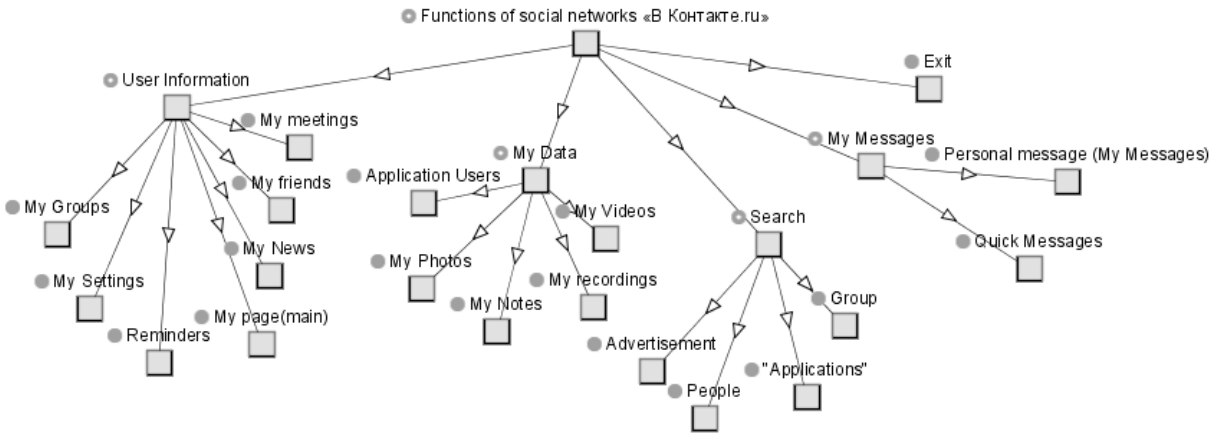


Figure 10. The social network "В Контакте.ru" systemological informative functions placement.

2. Analysis of the Use Possibilities of the Existing Methods of Tacit Knowledge Exchange.

One of the most important functions of the social network creation in the organization is tacit knowledge exchange and its formalization. To better understand the tacit knowledge exchange methods it is necessary to know the definition of the term "tacit knowledge". Resulting from the Internet resources analysis the following definition of "tacit knowledge" has been chosen:

Tacit knowledge is intuition, experience, feelings, secrets of mastery, impressions, associations, skills [Maricheva, 2007].

The following tacit knowledge exchange methods have been considered and analyzed and the ways of their implementation by means of the social network have been briefly described, including:

- "Mentoring." The method consists in knowledge transfer from the domain experts to less experienced colleagues by means of their learning. When implementing this method there should not be technical problems in the social networks sites. Interacting in the Internet space and discussing the problems and the questions arising in the process of carrying out their functional duties, the employees exchange their experiences in solving various problems. The "Mentoring Circles" implementation by means of group discussing of different questions with the employees participation is also possible.
- «Storytelling» is a story about how it was. With the help of open messages and notes the company employees describe their trips, tours, talks. The employee tells all his impressions about the trip and answers various questions of colleagues, thus transferring his experience gained during the trip.
- "The portfolio of knowledge." It involves tracking the employees' hobbies and contacts. According to the received information, the slices of the employees' interests, communications and interactions are accomplished. This method implementation was originally founded in social networks. After reviewing the user personal page, as well as his activity at sending public messages, one can learn about his interests, hobbies, friends, relationships with other users. This allows the employees' knowledge and relations use with the greatest benefit for the organization.

After analyzing the methods described above, one can conclude that social networks in the Internet are able to practically implement the tacit knowledge exchange methods the company which will allow increasing the employees' intellectual level and the company competitiveness.

3. Knowledge Dissemination in an Organization Model Creation.

When choosing a social network it is necessary to take into account several factors, such as the creation goals, the project budget, the tasks which will be solved by means of the social network, the expected users' range. The informational business model of a social network choice, aimed at the concrete organization problems solving, will help to facilitate the process of choosing a social network.

Systemology application in social networks will allow increasing the functioning effectiveness of social networks, the networks implementation, facilitating the new functions implementation. Systemological research of social networks will allow systematizing knowledge in the social networks in the Internet domain and defining the appropriateness of various functions use in this or that social network, in a concrete organization.

Using the knowledge obtained during the social networks functions classification fragment creation, the informational business model of (Figure 11) describing the process of a social network in the Internet choice and creation for increasing the organization competitiveness. This model describes the main processes in the organization when choosing a social network (the definition of the goals and tasks solved by the social network; the means and the software tool for creating the social network choice; a brief description of the processes associated with the immediate introduction of a social network in operation, of the ways of promoting the social network use by the employees).

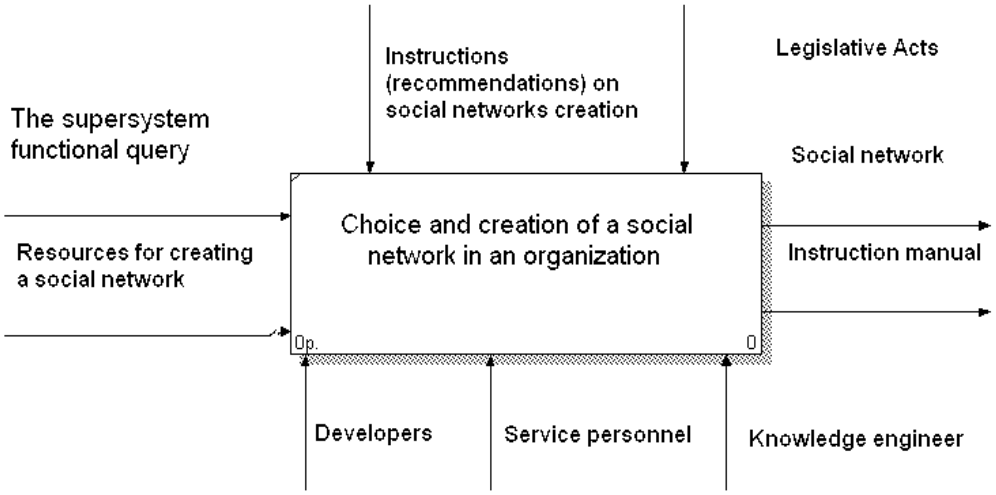


Figure 11. Context diagram of the informational model of the social network selection and creation in the organization.

In the future it is planned to develop the business model of social networks application in the Internet for knowledge management. The model will include the methods of exchanging both explicit and tacit knowledge of knowledge that will allow increasing the effectiveness of the social networks sites application in the organization for knowledge management.

The use of the created informational business model will allow facilitating and accelerating the Internet social networks choice and implementation process in the company and minimizing changes necessary for the effective functioning of the social network in the Internet; will allow reducing costs during the social network in the Internet creation and use.

The results of the work can be used as recommendations for the construction or choice of a social network by the organization for increasing its competitiveness, strengthening the relationships between the employees

(increasing the social capital), increasing the intellectual capital of the employees and of the company on the whole.

The use of social networks in the Internet by Ukrainian and foreign organizations will give them the opportunity not only to increase their competitiveness in the labor market, but also to create a strong foundation for further development.

Conclusions

The SCA innovative method application based on the NC criteria will allow obtaining the high-qualified parametric knowledge classifications in any, including - weak-structured domains, taking into account the objects essential properties and relations, acquiring and applying new deep knowledge. This allows solving effectively complete non-formalized theoretical and practical problems.

For example, the application of SCA and the NC criteria in SN allows to increase the effectiveness of their functioning (through the development of an effective system of functions and menus, optimizing the number of objects on one level of the hierarchy); to determine the appropriateness of using various functions in the SN, depending on the solving tasks. The use of knowledge systematization allows elaborating the rules for creating SN for organizations working in different spheres of activity. This will help the companies to increase significantly their intellectual capital without using large investments. The social networks use will allow to bring together the company employees forces for experiences exchange and solving problems, to create a favorable climate in the collective; to carry out continuous training with minimal financial costs, to accelerate the information exchange within the company. Widespread of SN among the users of the Internet makes them an effective tool for disseminating information. Creation and use of scientific and other social networks in the Internet will allow to assist effectively to the scientific community and the society in the whole development; to the development of the communities of practice as an innovative tool for solving concrete problems based on combining the potential of talented scientists, specialists and experts; to change management as a means of innovations and organizational development supporting.

Change management is very actual for the organization development and competitiveness increasing. That is why the change management subject domain research on the base of systemology and SCA (the fragment of which you can see in this work) is very important.

During the online store products catalog development, can be obtained the right classifications which reflect adequately the simulated domains, correspond maximally to their structure and semantics; to the formal-logical requirements (for example, the division base should not be changed) and to the systemological criteria; and that is why they are convenient for the user, ensure the successful search of a product (i.e. the user should easily find the product if it is in the catalog); maximally accelerate and facilitate the search. Such catalogs are easily expandable (adding new products and services), are convenient to maintain, can become the basis for automating many additional functions that are useful both for the user and for the online store owner.

The application of knowledge systematization in the organizations work will allow increasing the competitiveness level and the organization intellectual capital that will allow the organization to reach a higher level of development in relation to its competitors which do not use the knowledge management methods and technologies.

Acknowledgements

The paper is partially financed by the project **ITHEA XXI** of the Institute of Information Theories and Applications FOI ITHEA and the Consortium FOI Bulgaria (www.ithea.org, www.foibg.com).

Bibliography

[Бондаренко и др., 1998] Бондаренко, М.Ф. Основы системологии. [Текст]: Учеб. пособие // М.Ф. Бондаренко, Е.А. Соловьева, С.И. Маторин – Харьков: 1998. 118с

[Соловьева, 1999] Соловьева Е.А. Естественная классификация: системологические основания - Харьков: ХНУРЕ, 1999 - 222 с.

[Solovyova, 1991] E. Solovyova. Mathematical Modeling of Conceptual System: a Method and Criteria of a Natural Classification. / Automatic Document and Mathematical Linguistics. Allertion Press, Inc., New York, 1991, V. 25, No. 2.

[Solovyova, 2000] E Solovyova. Mathematical and Systemological Foundations of Natural Classification. / Automatic Document and Mathematical Linguistics. New York: Allerton Press, Inc., 2000. V. 33, No. 4.

[Бондаренко и др., 2004] Бондаренко, М.Ф. Моделирование и проектирование бизнес-систем: методы, стандарты, технологии. [Текст]: Учеб. пособие // М.Ф. Бондаренко, С.И. Маторин, Е.А. Соловьева; – Х.: «СМИТ» - 2004. - 272с

[Bondarenko et al., 2006] M. Bondarenko, K. Solovyova, S. Matorin and V. Matorin. Embedding Conceptual Models of Knowledge in Technology of Systemological Analysis. / Papers from the IFIP WG8.3 International Conference on Creativity and Innovation in Decision Making and Decision Support, vol. 2, p. 904-928, 2006, London, UK.

[Vanhoof et al., 2009] Koen Vanhoof, Mikhail Bondarenko, Kateryna Solovyova, Olexiy Ukrayinets. Systemological Language for Intelligence Business Modelling. Proceedings of the 4th International Conference on Intelligent Systems & Knowledge Engineering (ISKE2009). Vol.2 «Intelligent Decision Making Systems». P. 439 – 444, Belgium.

[Данилов, 2010] А.Д. Данилов До питання систематизації знань в галузі соціальних мереж // Вісник НТУ ХПІ «Системний аналіз, управління та інформаційні технології», зб. наук. праць. Харків: НТУ ХПІ, 67'2010. С. 84-90.

[Мариничева, 2007] М. Мариничева Едва ли мы знаем, что именно мы знаем или Несколько методов обмена скрытыми знаниями // http://it2b.ru/blog/arhiv/604.html.

[Bondarenko et al., 2010] Mikhail Bondarenko, Nikolay Slipchenko, Kateryna Solovyova, Viktoriia Bobrovska, Andrey Danilov. Systemological Classification Analysis In Conceptual Knowledge Modeling. // Information Book Series «INFORMATION SCIENCE & COMPUTING». Supplement to the International Journal «INFORMATION TECHNOLOGIES & KNOWLEDGE» 2010. Варна, Болгарія. Pp. 169-176.

[Мельников, 1986] Мельников Г.П. Разработка подсистемы лингвистического обеспечения АИС документально-фактографического типа в области материаловедения: Отчет о НИР/ СКТБ ИС ИПМ АН УССР.- N ГР 01.86.0103243.- М.: ВИНИТИ, 1986.- 452с.

[Маторин, 1998] Маторин С.И. Детерминантный анализ системы переработки информации человека // Проблемы бионики.– 1998.– №49.– С.72-80.

Authors' Information

Mikhail Bondarenko *– Rector of Kharkov National University of Radio Electronics, Corresponding Member of the National Academy of Sciences of Ukraine, Lenin Ave., 14, Kharkov, 61166, Ukraine; e-mail: rector@kture.kharkov.ua*

Major Fields of Scientific Research: System Analysis, Intelligence Technologies, Information and Knowledge Management, Artificial Intelligence, Decision Making Support., Knowledge Research and Application, Natural Language Processing, Knowledge and Natural Language Modeling, Business Intelligence, Competitive Intelligence, Modern (e-) Learning, Knowledge-Based Systems and Technologies.

Nikolay Slipchenko *– Chief of Scientific Department, Kharkov National University of Radio Electronics, Professor, Doctor of Technical Sciences, Lenin Ave., 14, Kharkov, 61166, Ukraine; e-mail: slipchenko@kture.kharkov.ua*

Major Fields of Scientific Research: System Analysis, Intelligence Technologies, Information and Knowledge Management, Modern (e-) Learning, Competitive Intelligence, Artificial Intelligence, Decision Making Support..

Kateryna Solovyova *- Chief of Social Informatics Departmen and Knowledge Management Center, Professor, Doctor of Technical Sciences, Kharkov National University of Radio Electronics, Lenin Ave., 14, Kharkov, 61166, Ukraine; e-mail: si@kture.kharkov.ua*

Major Fields of Scientific Research: Knowledge Classification, Systematization, Elicitation, Acquisition and Modeling, Knowledge Management, Ontological Engineering, Systemological Analysis, Knowledge Research and Application, Knowledge-Based Systems and Technologies, Artificial Intelligence, Business Intelligence, Modern (e-) Learning, Competitive Intelligence, Cognitive Modeling, Decision Making Support.

Andrey Danilov *– Social Informatics Department, Kharkov National University of Radio Electronics, Engineer, Lenin Ave., 14, Kharkov, 61166, Ukraine; e-mail: si@kture.kharkov.ua, Skil06@ukr.net*

Major Fields of Scientific Research: Social Networks, Ontological Engineering, Competitive Intelligence, Intelligence Technologies, Knowledge Research and Application, Knowledge Management, (e-) Learning, Artificial Intelligence, Systemological Analysis, Social Capital, Decision Making Support.

Ruslan Kovalchuk *– Social Informatics Department, Kharkov National University of Radio Electronics, Engineer, Lenin Ave., 14, Kharkov, 61166, Ukraine; e-mail: si@kture.kharkov.ua, tochka.ru@ukr.net*

Major Fields of Scientific Research: Knowledge Management, Ontological Engineering, Competitive Intelligence, Knowledge Research and Application, Artificial Intelligence, Systemological Analysis.

Irina Shcurenko *– Social Informatics Department, Kharkov National University of Radio Electronics, Engineer, Lenin Ave., 14, Kharkov, 61166, Ukraine; e-mail: si@kture.kharkov.ua.*

Major Fields of Scientific Research: Ontological Engineering, Intelligence Technologies, Knowledge Research and Application, Knowledge Management, Systemological Analysis.

COGNITIVE MODELLING AS THE INSTRUMENT IN THE COURSE OF KNOWLEDGE OF LARGE SYSTEM

Galina Gorelova

Abstract: *In this report we observe the possibilities offered by cognitive methodology of modeling of complex systems (social and economic, sociotechnical) and the developed software from positions of process of knowledge of complex object, and also extraction of different aspects of knowledge from the data about an object. The maintenance and program of researching of complex systems are set in the form of model of a metaset of the researching system, which distinctive feature is the description not only of big system and its interaction with environment, but also introduction in a metaset of "observer" that allows to build methodology of research and decision-making taking into account development of process of knowledge of object in consciousness of the researcher. Generally the model of the complex system is under construction in the form of hierarchical dynamical cognitive model. The mathematical model is exposed to formal researches. Connectivity, complexity, controllability, stability, sensitivity, adaptability and other properties of model on which the conclusion about presence (absence) of similar properties at studied big system becomes are analyzed. In the course of research self-training of the analyst ("observer") takes place by using developed toolkit for extraction of knowledge of object and decision-making.*

Keywords: *The expert, extraction of knowledge, cognitive, complex system, model, behavior, structure, decision-making, information technology.*

ACM Classification Keywords: *I.2.0 General - Cognitive simulation*

Introduction

The certain experience of the work which have been saved up during a number of years in sphere of cognitive modeling of large ("big") systems (Gorelova, etc. (2002), (2005), (2006), (2007), (2009), (2010)) allows to understand both the developed and being developed formal models and methods of research of difficult systems as one of very effective tools of their knowledge and usage of results of this knowledge in practice. Application of cognitive approach is understood in this case in a context of continuous "interaction" of results of knowledge by the subject of difficult object and the object itself, it is important to consider application, at least, in a view of three positions: first - the "utility" ("harm") of consequences of accepted decisions for object, then from theoretical positions of reception of new knowledge and from positions of "utility" of this knowledge for the subject.

In the first case it is especially important to understand "the risk of the human factor". Considering the weakly structurance of problems of the big systems, difficultness of "correct" gathering and processing of the information about them, "correctness" of the aim of research (an explanation of the mechanism of the phenomena of forecasting, management, generating of administrative decisions, etc.), it is necessary to take in a view the necessity to have the convenient tool for research and decision-making support.

By this time, many tool means of support of decision-making, including, various intellectual systems are developed. But thus it is not given special attention to a question how to consider process of knowledge during

research and accumulation of knowledges, feedback between results of knowledge an object by the subject is not formalized. The problem of understanding of process of knowledge of difficult object and "management" of this process thereby becomes complicated. Proceeding from the aforesaid developing methodology of cognitive modeling is a product of generalization and usage of achievements of the theory of systems and the system analysis [Volkova, Denisov, 2005], researches of operations, statistics, mathematical programming, the theory of management, the theory of decision-making, intellectual systems, etc. We stand on a position that now one theory, one method (or even the group of methods) don't allow to consider all aspects of problems of the big system, more often the part of the phenomena on which the attention of the researcher is directed or which was defined by the social order is considered. But thus there are many questions. For example, how the analyst has ideas of application of knowledge from this or that area to studying of concrete object? How, in what sequence and why they are applied? How all it directs knowledge process? Whether it is possible to operate this process? And to what results it can lead? It is possible to search for answers to these questions, leaning, including, on collected results of cognitive researches of the big systems, for example, [Trahtengerts, 1998], [Maxims, Covrege, 2001], [Kulba, 2002], and also on own researches of regional social and economic systems as a whole, and separate subsystems.

In section 2 the basic used concepts and definitions are resulted; section 3 is devoted a question of formalization of process of research of difficult object; in section 4 short representation of the system problems forming methodology of cognitive modeling is given. In section 5 the methodology scheme of cognitive modeling is presented.

1. The basic concepts

In the given work a number of the widespread concepts which sense it is necessary to explain according to spent cognitive researches is used.

«*The big system*» – is understood in sense, for example, of the researches of Institute of problems of management of the Russian Academy of Sciences (Management of the big systems). The big system («*large-scale systems*») is «*the complex system*», the term used in many works (for example, [Casti, 1979], [Klir, 1988]).

First, it is characteristic for the big systems to have a large quantity of elements and communications, interactions between them, but it is not enough for this sign. It is essential that the complexity of the structure formed by these elements – multilayered, hierarchical, etc. Often weakly enough interactions raise complexity of system. Secondly, it is a dynamics of system [Malinetsky, Potapov, 2000], complexity of its behavior. Probably, even unpredictability of behavior. Thirdly, there are regularities inherent for such systems which yet all are not studied yet up to the end.

Let"s name the major of these regularities [Volkova, Denisov, 2005]: ones of interaction of parts and whole (integrity, integration); regularities of hierarchical orderliness of systems (communicativeness, hierarchy) - this group of regularities is closely connected with one of wholeness, with a dismembering of a whole on parts, interaction of system with environment, i.e. abovesystem, and the subordinated systems; regularities of functioning and development of systems (historicity, self-organizing); laws of practicability of systems (equifinality, the regularity of a necessary variety, potential efficiency).

Fourthly, there are problems inherent for such systems: weakly structural and not structured (systems with the structured problems less concern to difficult, than others). *The structured problems* are those ones in which

essential dependences are clearly expressed and can be presented in numbers or symbols. These are problems "quantitatively expressed"; the decision of problems of this class uses methodology of researching operations. *Non structured problems* - are those ones that expressed in qualitative signs and characteristics, they don't give in to the quantitative description and numerical estimations. Researching of such problems is possible by using the probably heuristic methods, and there is absence of possibility to apply logically ordered structures of searching decisions. Weakly structured problems are characterized by presence both qualitative, and quantitative elements. Uncertain regularities are not giving in tthe quantitative analysis, dependence, signs, characteristics tend to dominate in these mixed problems. The majority of the most challenges economic, technical, political, strategic, etc. character problems concern to this class. «Weakly structurance » concerns more likely an information component - degrees of knowledge of the person, making the decision (the expert, an analyst). «Structural Degree» of the problem can be connected s with an information situation.

It is offered to allocate following situations: 1) basic uncertainty (the quantum mechanics); 2) the uncertainty generated by the general great number of objects, included in a situation (for example, 109); 3) the uncertainty caused by a lack of the information and its reliability owing to technical, social and other reasons; 4) the uncertainty generated by too high payment for definiteness; 5) the uncertainty generated by the decision-maker owing to a lack of its experience and knowledge of factors, influencing decision-making; 6) the uncertainty connected with restrictions in a situation of decision-making (time, the finance, etc.); 7) the uncertainty caused by behavior of environment or the opponent, influencing decision-making process.

All aforesaid characterizes the big system and its complexity. In the course of system knowledge there is «an uncertainty disclosing». And the more successfully, than more absolutely the used by an analyst tool is, the more above his professionalism and understanding of own process of knowledge are then, whenever possible, it is to "operate" this process. «Uncertainty Disclosing» is understood as process of cognitive structurizations of knowledges of the expert. Formalization of this process can be begun with formalization of concept of the "system" and workings out of model of research.

2. Formalization of the problem research

It is possible to track evolution of using categories of the theory of knowledge (cognitive theory) in researching activity [Volkova, Denisov, 2005], [Gorelova, Zaharova, Radchenko, 2006]: originally models (especially formal) are based on the account only elements and communications, interactions between elements; further elements, communications, the purposes (searching methods of the formalized representation of the aim – criterion function, criterion of functioning etc.) are considered; then - elements, communications, the purposes and more and more attention to the observer, the person which makes experiment, models, makes decisions; as a result - the product of knowledge (model) forms process of knowledge, and as a result of the next stage of process of knowledge – there is a model again etc.

The maintenance and the program of research of difficult systems can be set in the form of *model of a metaset of the system of research* (the metamodel offered by Kulby in his works became initial):

$$M = \{M_O(Y, U, P), M_E(X), M_{OE}, M_D(Q), M_{MO}, M_{ME}, M_U, A, M_н\} \quad (1)$$

Where MO (Y, U, P) – is the identifying model of system (object model), in which vector Y – endogenic variables $y \in Y \subseteq E^m$, characterizing a phase condition of object, U – a vector of operated variables $u \in U \subseteq E^r$, P, P – a vector of the allocated resources $p \in P \subseteq E^s$; MO (Y, U, P) = {MΦ, Stat}, Stat – statistical models; MΦ – the modified

parametrical vector count; ME – environment model, X – exogenic sizes; Mo_E = {$M_{YS\chi}$, M_{YS} } – model of interaction of object and environment ($M_{S\chi}$ – models of communication with environment in an input, M_{YS} - models of system communication with environment on an exit); $M_D(Q)$ – model of behavior of system, Q – revolting influences, M_{MO} and M_{ME} – models of measurement of a condition of system and environment; MU – model of the managing director of systems (doesn't join in a metaset if object research problems dare only); A – a rule of a choice of processes of change of object; M_H – model of "observer" (the engineer-kognitiologa, the expert, the researcher). In this metamodel that it considers not only system, but also its environment, interaction with environment is essential. Besides, introduction in a metaset of M of "observer" allows to build methodology of research and decision-making taking into account development of process of knowledge of object in consciousness of the researcher.

Models of system, environment, their interaction is the cognitive models (cognitive cards); models of behavior of system are the impulse processes or scenarios of development of situations. Working out of such models is included into process of cognitive structurization of knowledge of the expert. Working out of a metamodel (1) fixes the purposes, research problems and decision-making, allowing to observe all the picture as a whole, without losing details. Depending on the purpose the concrete models making a metamodel are under construction. It is necessary to make an important conclusion: the decision of weakly structural problems in complex systems demands the interdisciplinary approach. In our researches this approach is realized by means of *cognitive modeling, cognitive associations* of isolated knowledge in various fields of knowledges.

So: the basic distinctive feature of our researches – *cognitive association* in system both known, and again developed methods and the models created in the process of knowledge of object by the subject. Cognitive association is the process occurring in consciousness of the expert. And -that this is the main thing! - it is carried out by the continuous, cyclic decision-making process by the expert supported by special tool means. We now are on a way of working out of corresponding supporting mathematical and program toolkit for this purpose [Gorelova, Zaharova, Radchenko, 2006]. Also we try to understand and explain, why and how such association occurs. And how can it be used practically. Probably, all it also is sphere of contact of various researches in area of cognitive sciences.

Now we understand under *cognitive modeling* is the decision of the interconnected system problems: working out cognitive models; the analysis of ways and cycles of cognitive models; the scenary analysis; decisions of opposite problems; observability and controllability of system; stability; complexity and connectivity of system; decomposition and compositions; optimization; forecasting; accidents; adaptations; self-organizing; sensitivity; decision-making. The book [Casti, 1979] became a starting point for allocation of interrelation of these system problems. First four problems are traditional enough in cognitive analysis, there are software for their realization (for example, program complexes "Situation", "Compass", "the WHALE", developed in ИПУ the Russian Academy of Sciences). Other problems, are those ones: that are a subject of our theoretical and practical workings out now.

3. Representation of the primary goals, models and methods in technology of cognitive

It is possible to track evolution of using categories of the theory of knowledge (cognitive theory) in researching.

Technology of cognitive modeling represents certain system of statement and the decision of the designated systemic problems directed on this or that of research objectives.

1) Working out of *cognitive model* is the most creative and weakly formalizing stage in activity of the researcher (a group of experts) of the big system. Partially formalization is possible at processing of the numerical data in the form of the statistical information by use of means of the intellectual analysis of the data (for example, Data mining). As sources of the information for definition of "qualitative" tops theoretical data can serve theoretical data in studied subject domain and the coordinated decisions of a commission of experts. It is necessary to pay attention to necessity of the "correct" name of top - unsuccessfully picked up names (concepts) deform results of research and can give answers not on those questions which have been put. A result of process of identification of difficult system at the first investigation phase is cognitive card G [Casti, 1979], [Maxims, Covrege, 2001], further it is offered to open this model, passing to hierarchical cognitive models or to system cooperating hierarchical dynamical cognitive models [Gorelova, Miller, Radchenko, 2006], [Gorelova G.V, Gorelova, I. S., 2007].

Where $JM\Phi_D$ - is the hierarchical count consisting of models in the form of modified parametrical vector functional counts [Roberts, 1978]; Gjk (St), $G_{j(k+1)}(St)$, – is dynamical hierarchical cognitive models j – systems (j=1,2, …, N; levels k, k≥ 2, E = {e k, k+1} - set of arches between levels k) with reconstructed structure St depending on influence of environment; X (St) – changing parameters of tops cognitive cards; F (St) – changing functional communications between tops; q - space of parameters of tops, t – time; Rst – rules of change of structures.

If the developed model leans on the fundamental law, proves by the true experiment, due to it can be proved it's *adequacy* to displayed system or processes (situations) in system (model is adequate in moderately completeness of products of initial data and knowledge).

2) *The decision of a problem of the analysis of ways and cycles of cognitive models* is made by traditional methods of the theory of graphs. Allocation of ways of the various set length allows to track and interpret sequences of relationships of cause and effect, revealing their features and the contradiction. Allocation of cycles (positive and negative feedback) allows to judge structural stability (or not) systems.

3) *The scenery analysis* allows to judge about behavior of system, scientifically expect the ways of its possible development. The analysis is spent by results of pulse modeling (Roberts (1978)). For generating of possible scenarios of the development of a system in tops of cognitive card there are brought hypothetical revolting or managing directors to influence. At entering of indignations Qi (n) the question is investigated, «and what will be during the moment (n+1), if …?». The set of realizations of impulse processes is «the development scenario», specifies in possible tendencies of development of situations. The situation in impulse modeling is characterized by a set of all Q and values X in each step of modeling.

4) *The Decision of a return problem* - is a search of such values of operating influences Q which can provide the desirable scenario of development of system. For the decision methods of mathematical programming (linear, nonlinear) can be used.

5) Decisions of problems of *observability and controllability* of system are interconnected. *An observability problem* – a problem of definition of sufficiency of measurements of target variables for definition of unknown initial values of inputs. *The controllability problem* is a problem about possibility of change of inputs of system depending on observable exits (the cybernetic or administrative approach).

6) *Decisions of problems of stability*. Stability – is a multidimensional concept. In researches of social and economic systems the term "stability" designates many aspects, not always accurately defined (stability of a financial system, stability of the organization). In the theory of management a concept "stability" is accurately

defined, there are developed measures of stability of system («stability on Lyapunov», etc.). There are considered two aspects of concept "stability": stability of system under the influence of external indignations at the fixed structure of system, that is when only the environment changes, and stability of behavior of system at changes of structures of system – structural stability (small changes in system structure cause small changes in its dynamics).

7) *The problem of complexity and connectivity of system*. The concept "connectivity" of system arises together with concept system "structure". With disappearance of structural connectivity the system disappears. The mathematical description of a problem of the analysis of connectivity most successfully turns out in language of the theory of graphs and algebraic topology. Graphical models allow to understand better the system, interrelation of its elements, force of their influence. Models are convenient for the visual analysis of connectivity and give the chance to carry out the methods of formal analysis of the theory of graphs. The second approach is based on research of topological properties of graphs' model on a matrix of relations of cognitive cards, the so-called q-analysis of connectivity of simplicial complexes [Atkin, 1997], [Barcelo, Kramer, 1998], [Gorelova, Zaharova, Radchenko, 2006]. From these positions connectivity of system is an algebraic concept and its studying is conducted in language of algebraic topology. Concepts of connectivity and complexity of system mutually caused. There are considered: *structural complexity, dynamic complexity, computing complexity, evolutionary complexity; internal and external complexity.* In order the system to realize the set of kind of behavior without dependence from external hindrances, it is possible to suppress variety in its behavior, only having increased sets of managements (a principle of necessary variety of Eshbi). Such ability of system characterizes «*complexity of management*». The system can't be "universally complex". It can be difficult from one positions and simple from others. "Complexity" of systems often leads to the next: that is easier at first to study elements, system components, and then, on the basis of the received knowledges to try to understand system as a whole. Therefore the problem of the analysis of complexity of system is connected with problems of *decomposition and composition of a system*.

8) *Problems of decomposition and composition of systems*. Theory-graphical models allow to understand in many cases how it would be possible to carry out system decomposition on smaller blocks without loss of those basic properties thanks to which the system is a system. But there appears *a problem of the best decomposition of systems*. For finaly measured spaces of conditions there are proved theorems (Zhordana-Gyoldera, the Crone-roudza …) that any final group can be constructed of the fixed set of simple groups and this set of groups (the theory of groups) is defined unequivocally. Somewhat these theorems give the best decomposition of certainly measured systems. All that gives the chance, irrespectivly of complexity of behavior of a system, to analyze system, studying only rather simple objects which incorporate by certain rules.

9) *The optimization problem* - is a problem of a choice of the best entrance variables by some criterion (system of criteria), operating influences (managements) which result system to a desirable (optimum) condition. The decision of a problem of optimization depends on a kind of mathematical model, from target (critarial) function and restrictions on it. The set of methods of optimization (mathematical programming) are developed that are grouped in three - five classes, different by ideology of search of optimum decisions (maximization of function without restrictions, numerical methods, search methods – regular, casual). Optimization methods pass in methods of search of classes of admissible decisions.

10) *Forecasting problems, a scientific prediction*. Forecasting by existing definition is a process of a prediction, a prediction of tendencies and prospects of the further development of those or other objects and their future

condition on the basis of knowledge of regularities of their development in the past and now. Forecasting distinguish from a scientific prediction, it solves narrower practical problems, rather than a scientific prediction. One of advantages of cognitive modeling is the possibility of formalization of processes of a scientific prediction.

11) *Problems of the theory of accidents (catastrophes)*. "Accident" occurs when a spasmodic change of target parameters at continuous change of inputs arises. Position of balanced conditions of a system depends on properties of behavior (dynamics) of a system. Therefore it is necessary to understand, whether and how dynamic properties will change at little changes of system. Studying of this problem has an important practical orientation for displacement of position of balance can lead to essential qualitative changes of behavior of system. One of tools of research of this problem is the *theory of catastrophes*.

12) *Adaptation problems*. The adaptability characterizes ability of system to perceive external influences (expected, unexpected) without irreversible catastrophic changes in its' behavior. In a sense *the adaptability is a measure of viability*, *survival rate of a system*. The concept of *an adaptability* is closely connected with concept of «attraction area» and with displacement of these areas under the influence of artificial or natural indignations. If these indignations translate system into the area of a catastrophic condition, so the system doesn't possess features of an adaptability in relation to the given class of indignations. Research of feature of an adaptability in mathematical terms demands definition of concepts of "admissible influences», "survival rate", etc.

13) *Self-organization problems*. For definition of concept "self-organization" it is necessary to consider concepts the *open* and *closed* systems. The open system (by definition L. Fon of Bertalanfi) - is the system, capable to exchange in weight, energy, and information with environment. The closed (selfcontained) system is deprived of these abilities. Nowadays open system is understood also as a system which possesses (A.A.Bogdanov's) *active elements*. For example, the organizational systems have active elements such as a person. For open systems the characteristic features are that the system purposes formed inside the system, instead of those ones that are set from the outside, as in the closed systems. In open systems the regularity of self-organizing is shown. *The regularity of self-organizing* - is an ability of system to resist the entropic tendencies, ability to adapt for changing conditions, changing if it is necessary its' structure, changing the purposes. The concept of self-organizing is connected with concept of adaptivity (adaptability). It was entered by J.Z.Tsypkin at modeling negentropic tendencies in technical systems and has developed the theory of adaptive systems. Further the term of "adaptability" has been transferred on organizational systems, but the term *self-organization* has appeared to be more substantial, then *organization increasing*. To research the regularity of self-organizing the big contribution was brought by I.Prigozhin who has begun *synergetrics*. For technical systems the self-organizing theory is developed by A.G.Ivahnenko.

14) *Problems of the analysis of sensitivity*. Sensitivity shows ability of a system to react to indignations caused by: structure changes, changes of character and force of communication between system blocks, to change of size and time of receipt of a signal. There is one more concept connected with sensitivity -*it is a sensitivity of decisions*. The matter is that parameters of models can't be measured absolutely precisely and their number also can't be precise. Besides, they can change in actual practice under the influence of the latent factors.

15) *Decision-making Problems*. Decision-making problems can be considered from two positions: as problems of acceptance of administrative and organizational decisions, and as the problems connected with modeling of systems and decision-making on the basis of modeling. Decision-making rules depend on conditions of uncertainty of functioning of the big system, from degree of knowledge of the person, making the decision. In a case when uncertainty is generated by behavior of environment, it is possible to use likelihood models of

problems of decision-making [Gorelova, Svecharnik, 1972], [Gorelova, Brawlers, 2007]- so-called «games with the nature». In case of conflict situations when decision-making in the conditions of conscious counteractions of any other system is considered, models of the theory of games ([Neumann, Morgenshtern, 1970], [Gorelova G.V, Gorelova I. S., 2007] are applicable.

In concrete system research the decision of all above-named problems isn't obligatory, but their complex represents itself as a complete research. As the decision of one problem often is the basis for the decision of the following one, and some of problems can't be solved without one another (a set of others).

4. The scheme of interconnected methods of cognitive methodology

At the present moment cognitive methodology (fig. 1) represents itself a system of models, methods, information technology for research of the big system (Gorelova, etc. (2005) – (2007), (2009), (2010)) which allows to solve interconnectively the primary goals of the system analysis that is necessary for an all-round substantiation of offered decisions on a desirable way of development of a system. There are: methods of formalization of the purposes; methods and models of the economic-mathematical and sociological analysis; methods of gathering and preprocessing of an actual material about social and economic system and environment; methods of cognitive structurizations. Methods are applied stage by stage and allow to formalize knowledges of experts in concrete subject area.

Conclusion

So, the decision of the system problems named above – is the means of more and more deep knowledge of properties of difficult system. There can be the question – what for are so much actions? Whether is easier ….? But: it is obvious that without model of difficult system (cognitive, in this case) and its analysis not only it's difficult, but more often it's impossible to understand, predict, develop and make decisions about the adaptation to system or management of it. In the course of research the chain of doubts is born: whether system and model displaying it "are correct"? What are the properties of structure and behavior of system? Whether the system is steady? Whether accident threatens? Can the system has properties of self-organizing, adaptation and is it necessary to do nothing? How much the system is sensitive to influences (to wrong decisions including)? Etc. – on a circle of the decision of system problems.

And these problems are desirable for solving in interconnection. Therefore for each of them there are separately developed methods that can be used in uniform system. These reasons have formed a basis for construction of cognitive methodology of research of the big systems and system of PM KM software supporting it. Thus, integration of possibilities of cognitive technologies with other informational technologies opens unique possibility within the limits of a uniform programme-analytical complex to spend strategic planning and operative reaction, to combine the fundamental and technical analysis of complex system.

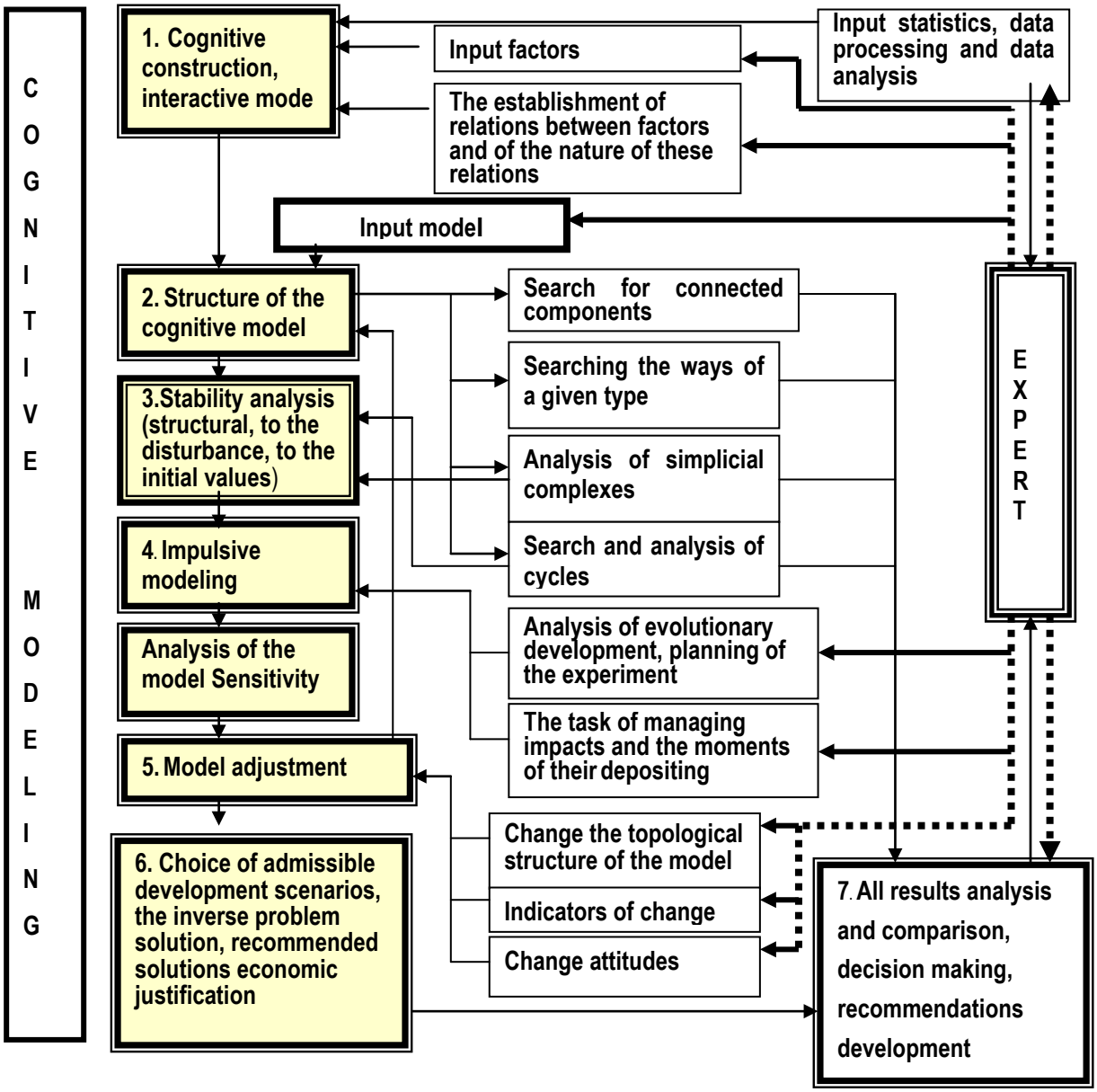


Fig. 1. The scheme of cognitive methodology, interrelation and sequence of application of methods

Bibliography

[Volkova, Denisov, 2005] Volkova V.N, Denisov A.A. Bases of the theory of systems and the system analysis, St.-Petersburg (in Russian), 2005, 520 p.

Gorelova G.V., Dzharimov, H.X. A regional education system: methodology of complex researches, Maikop (in Russian), 2002, 360 p.

Gorelova G.V., Zaharova E.N., Ginis L.A. The kognitivnyj analysis and modeling of a sustainable development of social and economic systems, Rostov n/Donu (in Russian), 2005, 288 p.

[Gorelova, Zaharova, Radchenko, 2006] Gorelova G.V., Zaharova E.N., Radchenko S.A. Research of weakly structured problems of social and economic systems: the cognitive approach. – Rostov n/Donu (in Russian), 2006, 332 p.

[Gorelova, Miller, Radchenko, 2006] Gorelova G.V., Miller E.V., Radchenko S.A. Modeling of processes of interaction and decision-making on maintenance steady and safe development of social and economic systems dynamical иерархичными когнитивными models. Works of 15th Mezhdun. conf. «Problems of management of safety of difficult systems», Moscow (in Russian), 2006, pp. 75-78.

[Gorelova, Brawlers, 2007] Gorelova G.V., Brawlers V. Formalization of likelihood problems of decision-making in intellectual systems on a basis of cognitive approach. Magazine "Artificial intelligence", Donetsk (in Ukraine), 2007, pp. 147-158.

Gorelova G.V., Matveeva L.G., Nikitaeva A.Y.. The system approach and instrumental maintenance management in the territorially-localized economic systems of mesolevel, Rostov-on-Don (in Russian), 2007, 160 p.

[Gorelova G.V, Gorelova I. S., 2007] Gorelova G.V, Gorelova I. S. About possibility of formalization of problem situations in the social environment on the basis of teoretiko-game and cognitive approaches. Works of Mezhdun. Scientifically-prakt. Multiconf, Donetsk (in Ukraine), 2007, pp. 114-117.

[Gorelova, Svecharnik, 1972] Gorelova G.V., Svecharnik, D.V. A method of an optimum of face value and its application, Moscow (in Russian), 1972, 200 p.

Koptjug V. A, Matrosov V. M, Levashov V. K. A new paradigm of development of Russia (complex problems of a sustainable development), Moscow (in Russian), 2000, 460 p.

[Kulba, 2002] Kulba V.V, Kononov D.A., Kovalevsky S.S., Kosjachenko S.A. The scenary analysis of dynamics of behavior of social and economic systems (Scientific edition), Moscow (in Russian), 2002, 122 p.

[Maxims, Covrege, 2001] Kognitivnye technologies – from ignorance to understanding. Works of Mezhd. «Kognitivnyj the analysis and management of development of situations (CASC ' 2001)». Vol.1. Moscow (in Russian), 2001, pp. 4-18.

[Malinetsky, Potapov, 2000] Malinetsky G.N., Potapov A.B. Modern problems of nonlinear dynamics, Moscow (in Russian), 2000, 336 p.

[Neumann, Morgenshtern, 1970] Neumann, J., Morgenshtern, O (1970). The theory of games and economic behavior, Moscow (in Russian), 1970, 709 p.

[Trahtengerts, 1998] Trahtengerts Y. A. Computer support of decision-making: the Scientifically-practical edition. A series "Information of Russia on threshold XX1 of a century", Moscow (in Russian), 1998, 376 p.

[Atkin, 1997] Atkin R. H. Combinatorial Connectivies in Social Systems. An Application of Simplicial Complex Structures to the Study of Large Organizations, Interdisciplinary Systems Research.

[Barcelo, Kramer, 1998] Barcelo, H., Kramer X., Laubenbacher, R., AND Weaver, C. Foundations of Connectivity Theory for Simplicial Complexes, Department of Mathematical Sciense, New Mexico.

[Casti, 1979] Casti, J. Connectivity, Complexity, and Catastrophe in Large-scale Systems. A Wiley – Interscience Publication International Institute for Applied Systems Analysis. JOHN WILEY and SONS. Chichester – New York – Brisbane–Toronto.

Gorelova, G.V., Verba, V.A., Buyanov, B.Y. Experience in cognitive modeling of complex systems. Cybernetics and systems 2010, Proceedings of the 20-th European Meeting on Cybernetics and Systems Research. – Pr. In Austria, Vienna, pp.220-223.

[Klir, 1988] Klir G.J. Architecture of systems problem solving. /State University of New York at Binghamton/ Plenum Press. New York and London.

[Roberts, 1978] Roberts F. Graph Theory and its Applications to Problems of Society, Society for Industrial and Applied Mathematics, Philadelphia, 494 p.

Authors' Information

Galina Gorelova *– Professor of the Department of state municipal low and administration, Technological Institute of South Federal University in Taganrog, P.O. Box: Nekrasovskiy 14, 347922, Taganrog, Russia; e-mail: g.v.gorelova@gmail.com.*

ELECTION DATA VISUALIZATION

Elena Long, Vladimir Lovitskii, Michael Thrasher

Abstract: *Data visualization has direct link to data interface, data capture, data analysis, and data presentation. At the present time there is still a huge gap between our ability to extract answers and our ability to present the information in meaningful ways. There is consensus that future breakthroughs will come from integrated solutions that allow end users to explore data using graphical metaphors - the goal is to unify data mining algorithms and visual human interfaces. The main purpose of our paper is to discuss one approach to that "breakthrough". The paper uses data from recent UK parliamentary elections to illustrate the approach.*

Keywords: *natural interface, data visualization, graphical interface*

ACM Classification Keywords: *I.2 Artificial intelligence: I.2.7 Natural Language Processing: Text analysis.*

Introduction

This paper represents results of our further research in the natural language and graphical interface to database (DB) [V.A.Lovitskii and K.Wittamore, 1997; Guy Francis *et al.*, 2007; Elena Long *et al.*, 2009; Elena Long *et al.*, 2010]. The data source addressed here is a DB containing the results of the 2005 and 2010 UK General Elections. The result shows the current vision of our *"natural interface"* that has been implemented **(http://141.163.170.152:8080/NITED/NITEDJSP.jsp)** as a Web application. This is termed "**NITED"** (**N**atural **I**nterface **T**o **E**lection **D**ata) where a user can see and interact with UK General Election data online. The aim of design is that the application must offer **simple, intuitive and responsive user interfaces** that allow users to achieve their objectives regarding information retrieval with minimum effort and time.

S. K. Card, J. Mackinlay, and B. Shneiderman [1999] define **info**rmation **vis**ualization (infovis) broadly: *infovis is the use of computers to interactively amplify cognition, using visual representations*. Therefore if we take this as our starting definition, systems must be computer-based, interactive, provide visual representations, and most importantly, **amplify cognition**. Our aim is that NITED meets these requirements.

Information visualization emerged and developed at the confluence of computer graphics, human-computer interaction, and databases [C. Ware, 2000; S. Card, 2003]. Continuing research in information visualization has produced a wide variety of techniques for displaying large multidimensional datasets on a computer screen and allowing users to identify complex patterns in multidimensional data. Here, we will take into account some distinctive features of election data and their potential for visualization.

People are increasingly relying on the Internet mass media as their primary source of visualizing election results. It is thus crucial for the media to develop the ability to provide accurate, informative, and user-friendly visualizations. However, this is not a straightforward task because of the complexity of the data. Because

elections visualization is such an important yet challenging task, it is useful to take into account its effectiveness. The effectiveness of the visualization not only of election results but also the visualization on Input User Interface is therefore very important, since it is the one visualization that people pay strong attention to. On the one hand, rather than have users struggle through tables of data, an effective visualization of the election results could potentially provide users with a more powerful understanding of the situation. On the other hand, a poorly-designed visualization may bring confusion rather than clarity. Worse still, such a poor visualization environment could persuade users to turn to competitor websites for their information requirements. From the user's standpoint some visualization may potentially lead them to draw incorrect conclusions about the data.

The principal purpose of our paper is to offer an Input and Output user interface which makes it easy, efficient, and enjoyable to operate NITED in a way which produces the desired result. This generally means that a user is required to provide minimal input to achieve the desired output. Essentially election data visualization is a graphical representation of data, and can be implemented in a variety of ways - from charts and graphs to more complex mapping of data that has the potential to optimise the flow of information to the end user. In this paper the process of output election data visualization will be discussed in details.

Reading this paper will tell you the following:

• User interface.
• Election interactive map.
• Drill down map.
• Drill down map creation.
• Drill down maps examples..

User Interface

The user interface (UI) for applications should be simple and intuitive for the end user - most users want to achieve the desired result whilst expending minimum effort. The end user should have a positive experience when using the application. This generally means that the user needs to provide minimal input to achieve the desired output, and crucially, that the application minimizes undesired outputs to the user. **NITED's UI has to be election domain specific** i.e. contents and features of **E**lection **A**pplication **D**omain (**EAD**) should define the strictures of Input and Output user's interfaces**.** It should describes how well an application can be used for its intended purpose by its target users with efficiency, effectiveness, and satisfaction Some general requirements of UI are discussed in our earlier paper [Elena Long *et al.*, 2010]. The "golden rule" to UI creation is that *the UI* should be made as simple as possible, but not simpler. The proper balance between simplicity and sophistication at the input side is the main requirement to NITED UI.

UI provides a means of:

- **Input** UI, allowing the user to manipulate an application, and
- **Output** UI, allowing the application to indicate the effects of users' manipulation.

NITED uses three different kind of **Input** UI:

- **Command-Line User Interface** (CLUI) which accepts two pairs of text commands: *"GE2005"* – *"GE2010"* to activate the corresponding Data Base (DB) and *"START"* to activate slides show regarding the General Election 2010 and *"STOP"* to quit it. Only text field, keyboard and mouse are required for CLUI. This interface is hidden as a less frequently used.
- The next two Input UI are GUIs. The great convenience of the GUI made it as the standard in human-computer interaction. The GUI generally provides users with immediate, visual feedback about the effect of each action. There are several general requirements to GUI:
  - Provide meaningful contrast between screen elements.
  - Create groupings.
  - Align screen elements and groups.
  - Provide three dimensional representation
  - Use colors and graphics effectively and simply.

Let us consider two Input GUIs.

- **Graphical Query Input User Interface (GQIUI)** is an interface to General Election DB. GUI is a user interface based on graphics (checkboxes, clickable images and list boxes of Regions, Constituencies, Parties and Candidates) instead of text; it uses a mouse as well as a keyboard as an input device. GQUI provides three different types of user's request:
  - **F**requently **A**sked **Q**uestion (**FAQ**).
  - **N**atural **L**anguage **E**nquiry **T**emplate (**NLET**) combines FAQ and a slot represented by variable in the square brackets, the value of which should be selected by the user from the corresponding list of values. For example, "*In which constituency did [party] achieve its highest vote?*"
  - **N**atural **D**escriptors **E**nquiry (**NDE**). Such enquiries permit users to communicate with a DB in a natural way rather than through the medium of formal query languages.

These three types of user's requests are described in greater detail in our paper [Elena Long *et al.*, 2010].

- **Graphical Charts Input User Interface (GCIUI)** provides the direct way to accomplish chart creation as a response to user's request represented only by FAQ which are classified into 3 parties (Conservative, Labour and Liberal Democrat) groups to see how they are oriented in the UK map of regional spaces, for example, party performances in the South West of England, in Scotland or in Wales. These three parties were selected initially because the election results among them and other parties are not compatible because of differential patterns of party competition (see Figure 1). GCUI is a very useful method for the analysis of election data. For example, NITED displays the results using interactive maps. Initially the user is shown the UK map with selectable regional areas. When a region is selected, the NITED will direct the user to an analysis of its election results. Let us distinguish two parts of GCIUI: **fixed** and **dynamic**. Fixed GCIUI is based on a list box of FAQ, radio buttons group, map of Regions and clickable images of buttons. Dynamic GCIUI will be described below.

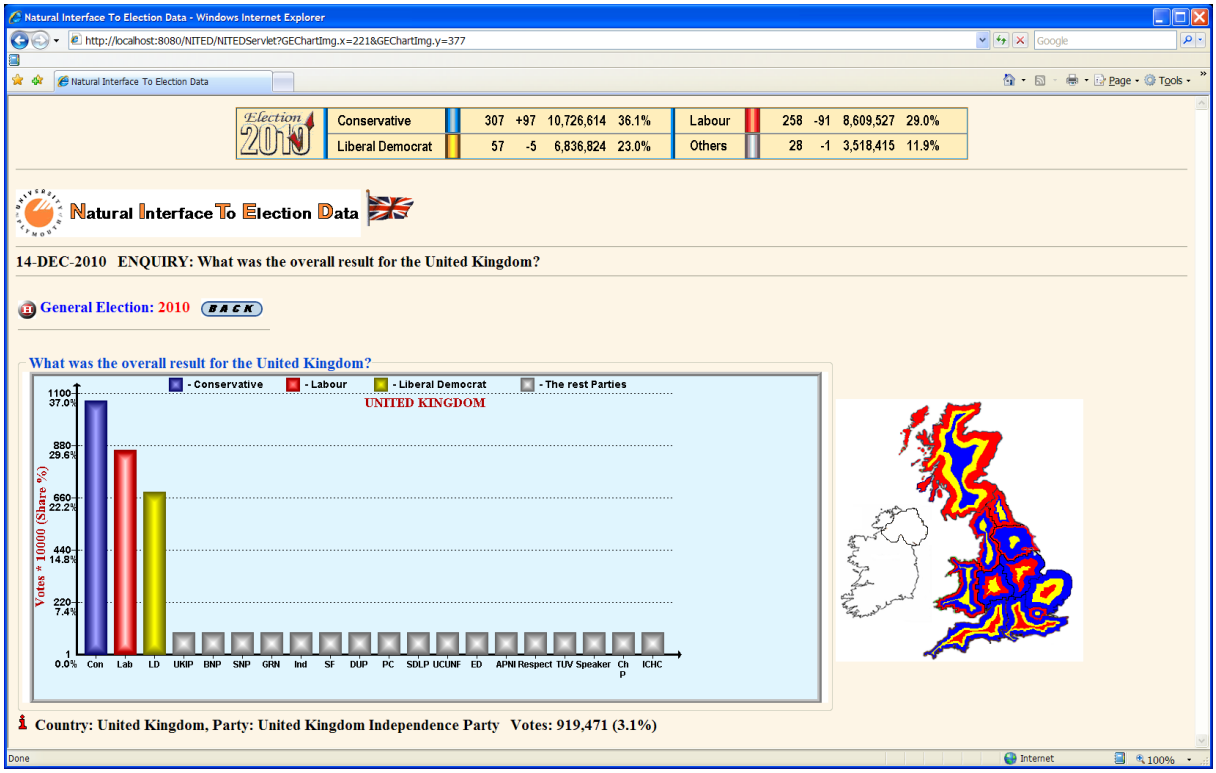


Figure 1. Chart result of the GE 2010 in the *United Kingdom*

NITED distinguishes two different types of **Output** UI:

- **Table Output** (**TOUI**) is the general and natural way to represent the result to user's request.
- **Chart Output** (**COUI**) allows the user to see the election data. COUI should satisfy some basic criteria in order to be useful for users:
  - Charts should be designed to encourage the user to make comparisons between discrete elements of data, for example, difference in vote share across constituencies/regions.
  - COUI should provide views of the data at many levels of detail. This principle relates to the ***"Drill down"*** and ***"Level-Of-Detail"*** capabilities of visualizations. With these capabilities, NITED can allow a broad overview of the data to be given and, at the same time, allow the user to have access to the detailed data that underlies the overview.
  - Maps are a potential "natural" representation for entities that can be analyzed geographically. For example, if a user would like to see how some region is performing in comparison to other regions in terms of party votes, the user could look at a map-based chart type of visualization. A map-based representation can become a true multivariate representation.

Input and Output UIs interactions is shown in Figure 2. GQIUI always first of all produces the TOUI. But NITED, as an intelligent system, analyses the result to discover whether it is logically appropriate to represent the output as a chart as well using COUI. If answer is YES TOUI displays button *"Chart"* (see Figure 3). As a result of clicking this button NITED substitutes TOUI for COUI (see Figure 1). COUI represents the **dynamic** part of GCIUI

and a user can click any histogram to see the result for the selected party. *Charts* should be preferred to *Tables* whenever it is important for users to quickly and easily recognize characteristics of and patterns in data.

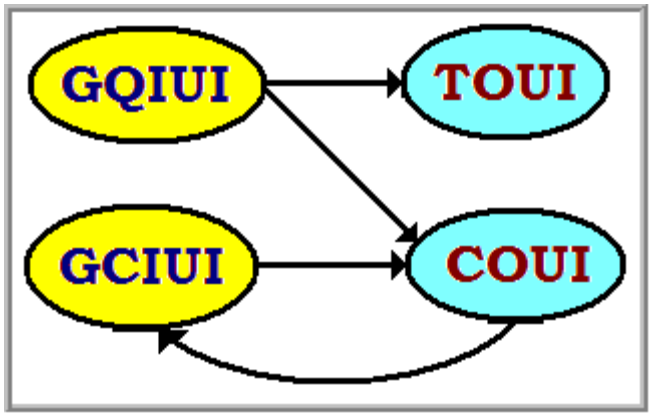


Figure 2. Input and Output UI Interaction

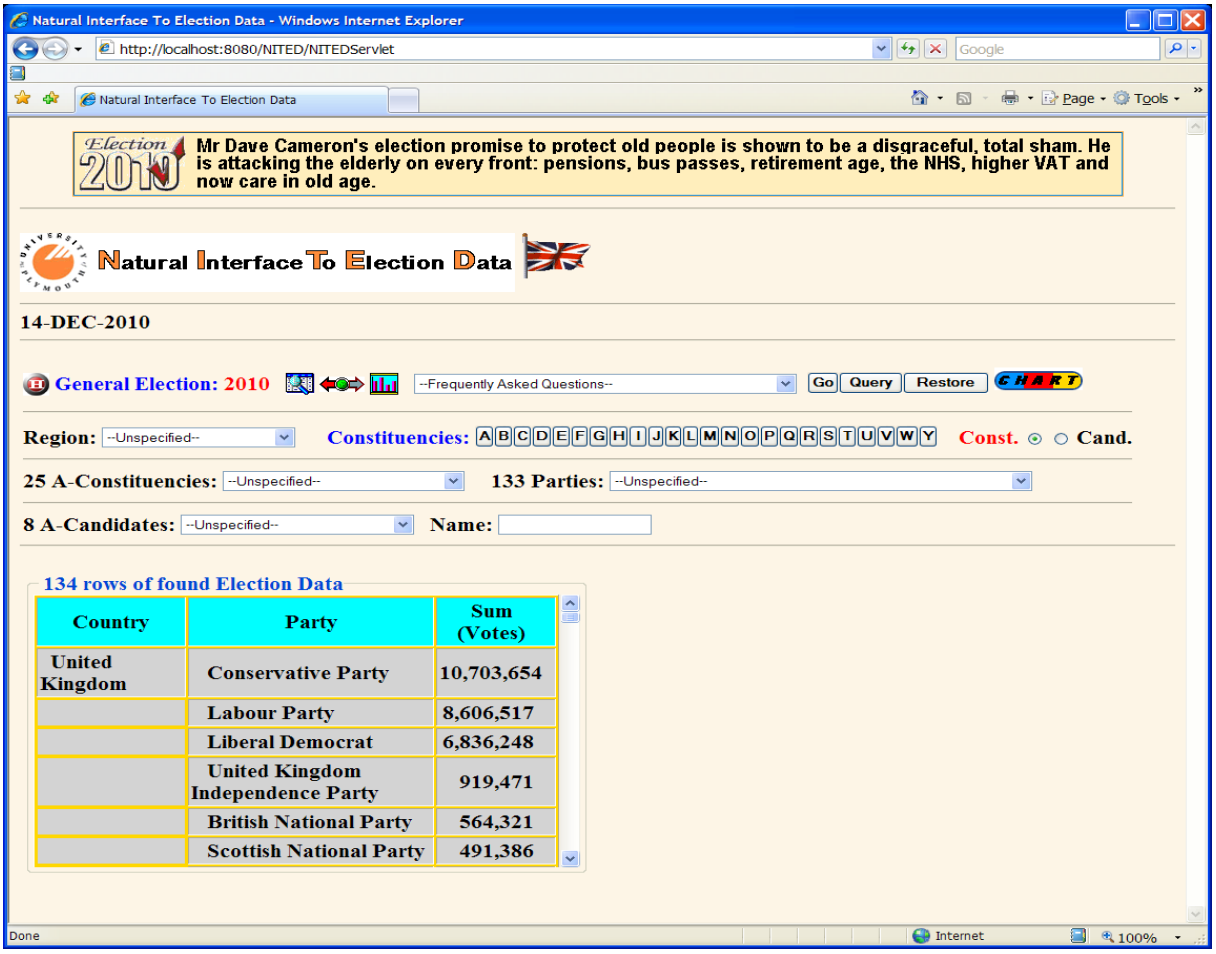


Figure 3. Table result of the GE 2010 in the *United Kingdom*

Election Interactive Map

The expansion of Web technology over the past decade has created fresh opportunities for presenting data online. One of the most rapidly improving tools for interactive presentation is the map. Interactive maps on the Internet **present data most effectively when they invite action from the user**. Showing relationships between data is easier when the user has the power to change the visuals. Drilling down is fundamental to the interactive map. These actions enable the user to focus their browser on the amount of information that they are comfortable with.

More recent developments have included interactive data visualization which can quickly respond to new data or collect data about the user to better refine the visualization which take advantage of the power to quickly recalculate and display to find unexpected patterns, and proximity mapping that use the relationships between people, concepts, or words to determine proximity.

When a parliamentary election was over, the country's voting patterns were mapped and broken down by region. The election result was directly tied to a particular area. The interactive map enables the user to focus NITED on the amount of information that they are comfortable with. Each change in the behaviour of the NITED should be accompanied by a corresponding change in the appearance of the interface.

For user convenience, a Regions' legends are added at the top (see Figure 4) allowing the user to choose which region's data should be represented. The user can then view the results for a single constituency or the total votes and vote shares across each region.

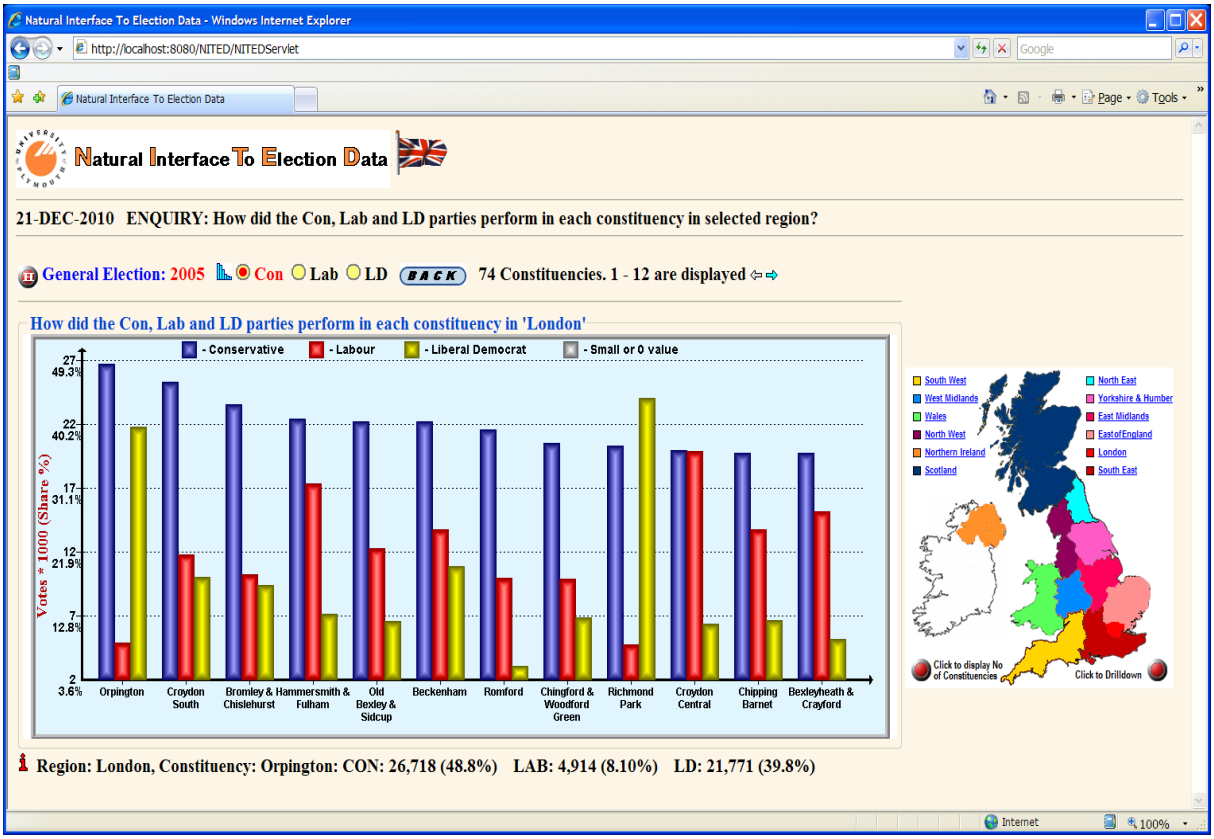


Figure 4. Constituency results of the GE 2005 in London

Drill Down Map (DD-Map)

When the user has to move through various levels of specificity of data, a drill down style of navigation is commonly offered. The drill-down clearly groups information of magnitudes ranging anywhere from the "big picture" down to an individual case.

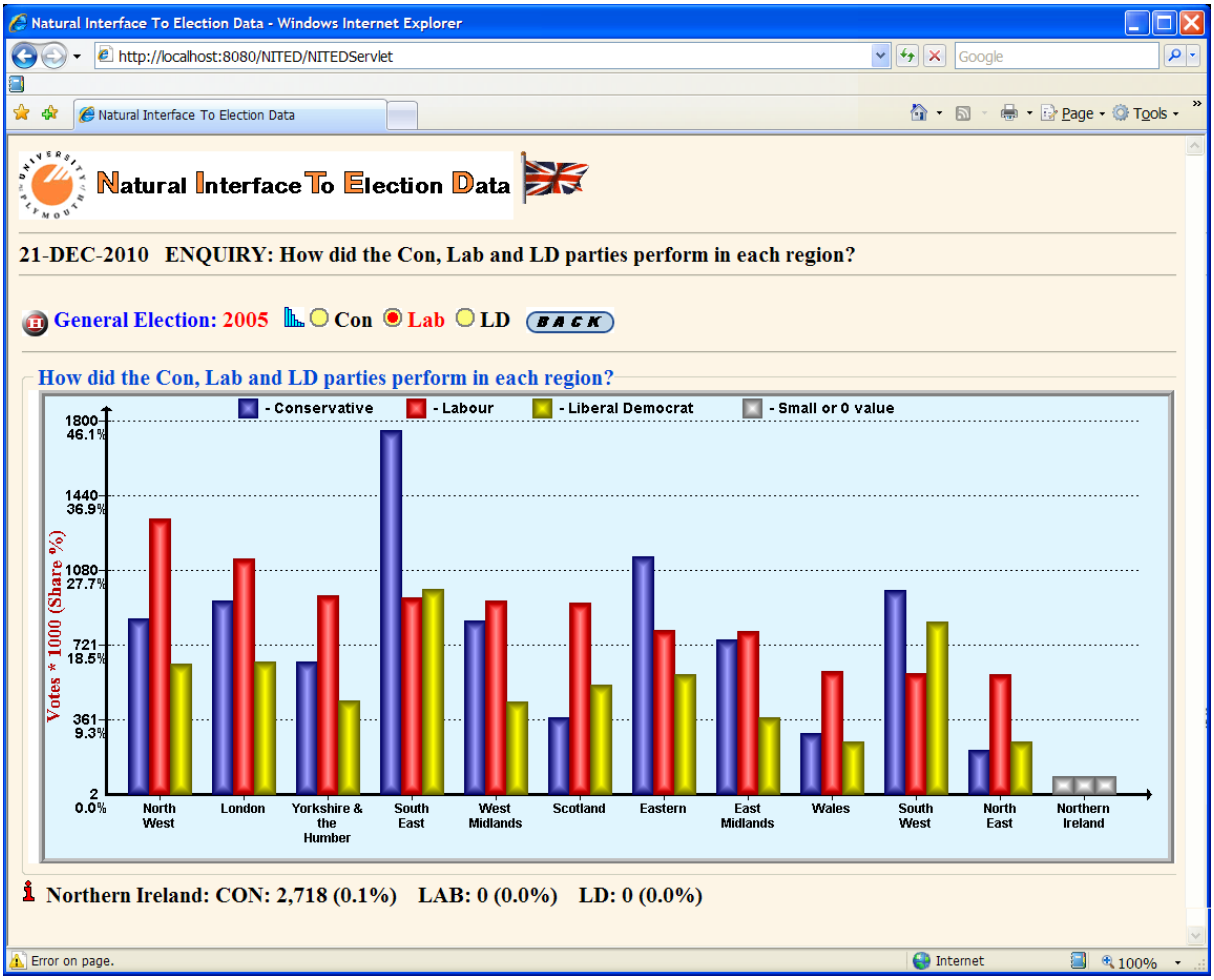


Figure 5. Regions results of the GE 2005

One Chart diagram (see Figure 5) shows that Conservatives "won" in three English regions and also in Northern Ireland (purely an artifact of party competition given that only the Conservatives of the three main parties contested seats in Northern Ireland at the 2010 general election) and that is why in the Regions' Map (see Figure 6) those regions are coloured blue (the standard colour of the Conservative party). Charts are preferred to Tables: a single chart conveys important features of the data more vividly and memorably than columns of data.

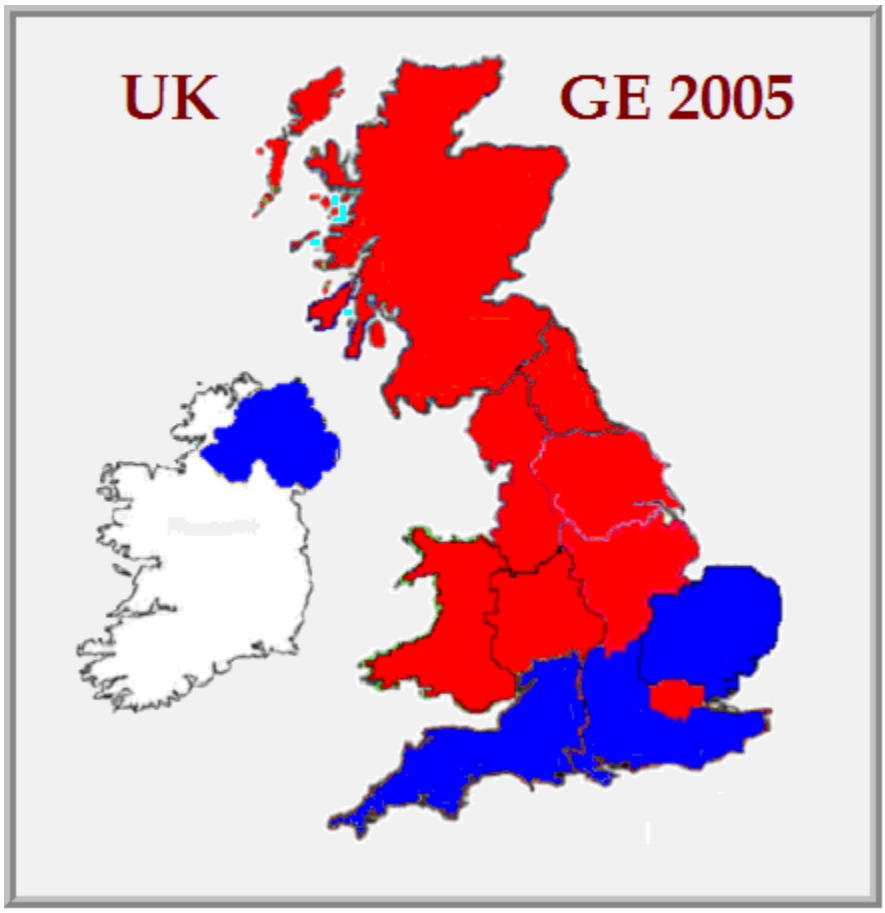


Figure 6. Results of the GE 2005 by Regions

The main purpose of using the map is to show thematically relevant information in an easily interpreted manner**. But, what is the value of such a map?** At one level of understanding the map shown in Figure 6 does not work. The regions are unequal in area giving the user a false impression of the mapped data distribution. People, not familiar with the UK voting system and the way in which votes are translated into seats, might assume that Labour won a clear majority of UK votes. However, the race was much closer. Labour won 35.2%, Conservatives - 32.3%, and Liberal Democrats won 22.0% of votes. Displaying simply the colour of a regional winner does not show the real distribution of votes between Labour, Conservative and Liberal Democrat in each region. For example,

East Midlands:	**LAB:** 785,943 (**39.0%**)	**CON:** 747,438 (**37.1%**)	**LD:** 372,041 (**18.5%**)
North West:	**LAB:** 1,327,668 (**45.1%**)	**CON:** 846,195 (**28.7%**)	**LD:** 629,250 (**21.4%**)
Scotland:	**LAB:** 922,397 (**39.5%**)	**CON:** 369,388 (**15.8%**)	**LD:** 528,076 (**22.6%**)

The attempt to produce a map depicting the results by voting percentage (i.e. each region's colour is a mix of red, blue and yellow colours in proportion to the results for that region) was not a total success [Stephen L. Sperry, 2006]. We decided instead to change colour of region in proportion of votes **change square size of region in proportion to the result** i.e. the initial size e.g. of the East Midlands region from map in Figure 6 equal 100%, or 785,943 votes. The size of the East Midlands region for Coservative party should be less and occupied **95.1%** = 747438 / 785943 * 100 of initial Labour map, and size of Liberal Democrat map should be significantly less and occupied just **47.34%** of initial Labour map. When the sizes are changed and region maps are coloured accordingly they are placed one above another in descending order. Such map we called **D**rill **D**own **Map** (**DD-Map**). The subsequent DD-Map displaying the result of the 2005 election by regions is shown in Figure 7.

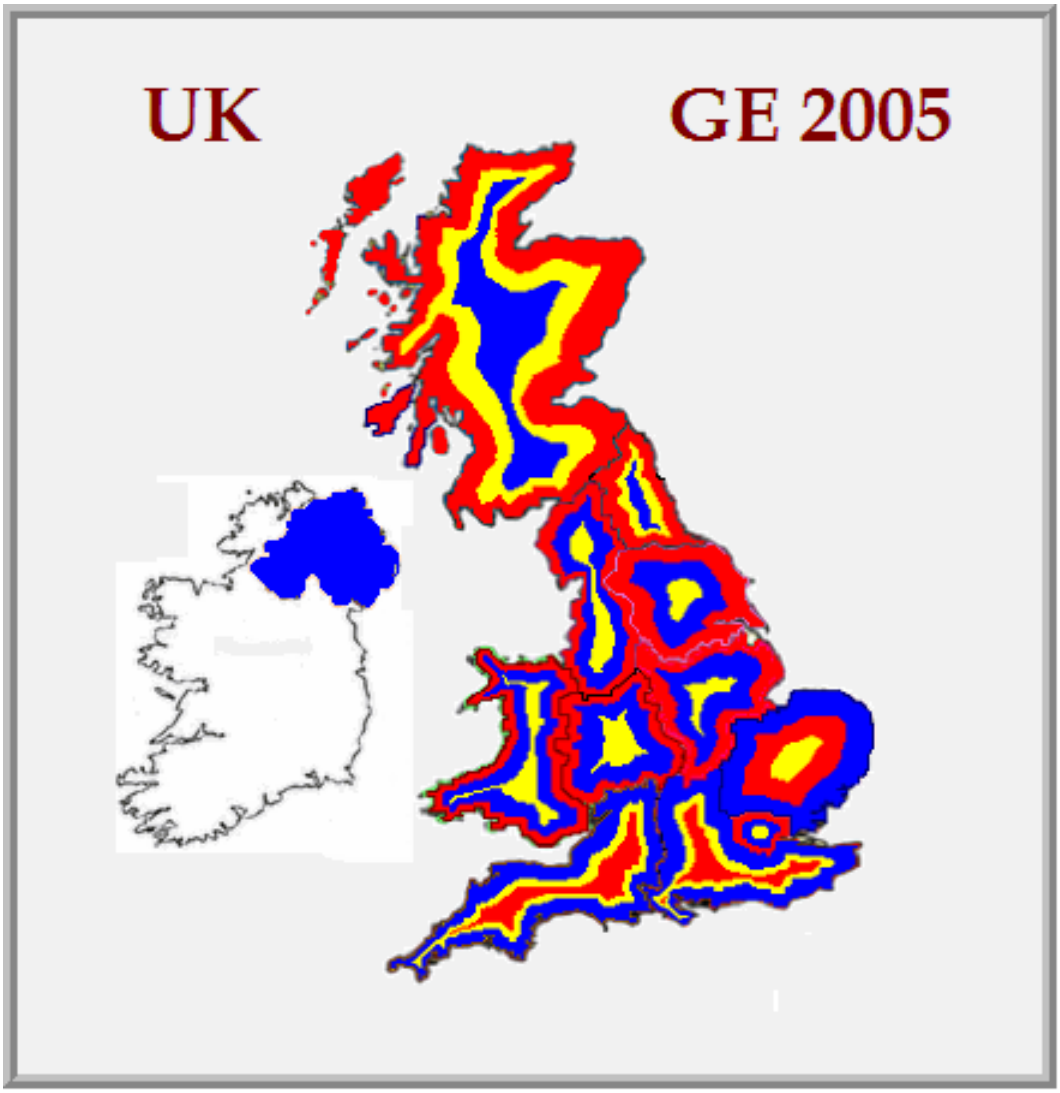


Figure 7. DD-Map of the GE 2005 by Regions

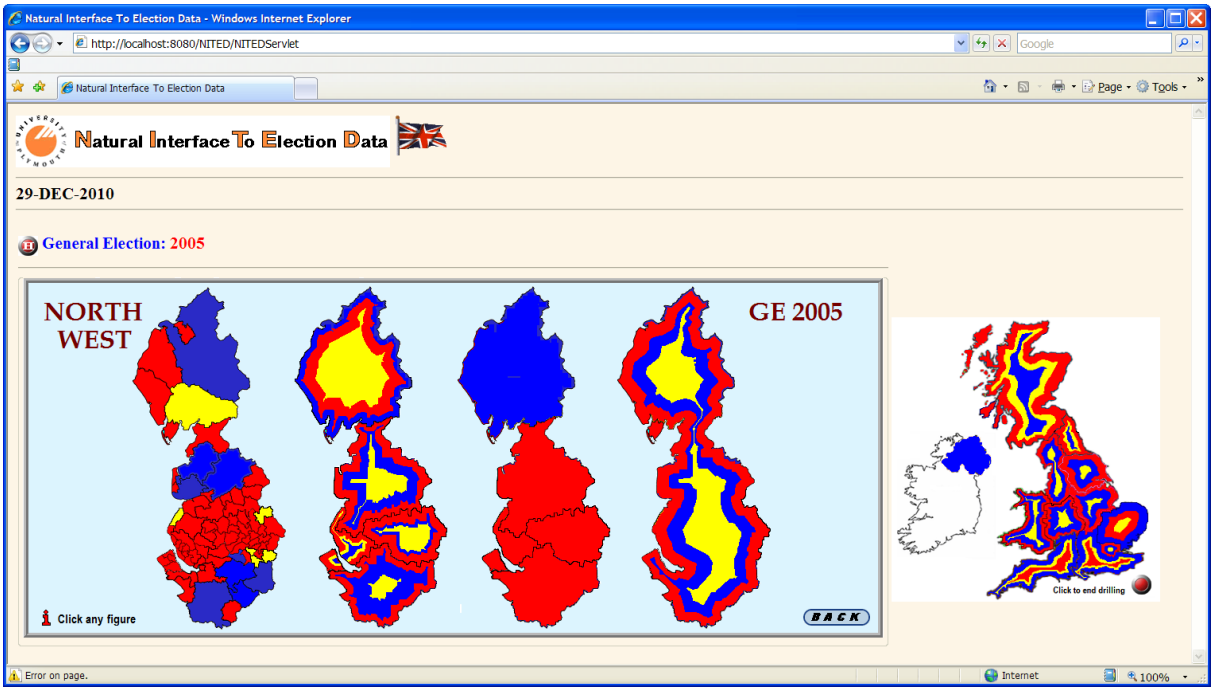


Figure 8. DD-Map of the GE 2005 for the North West region

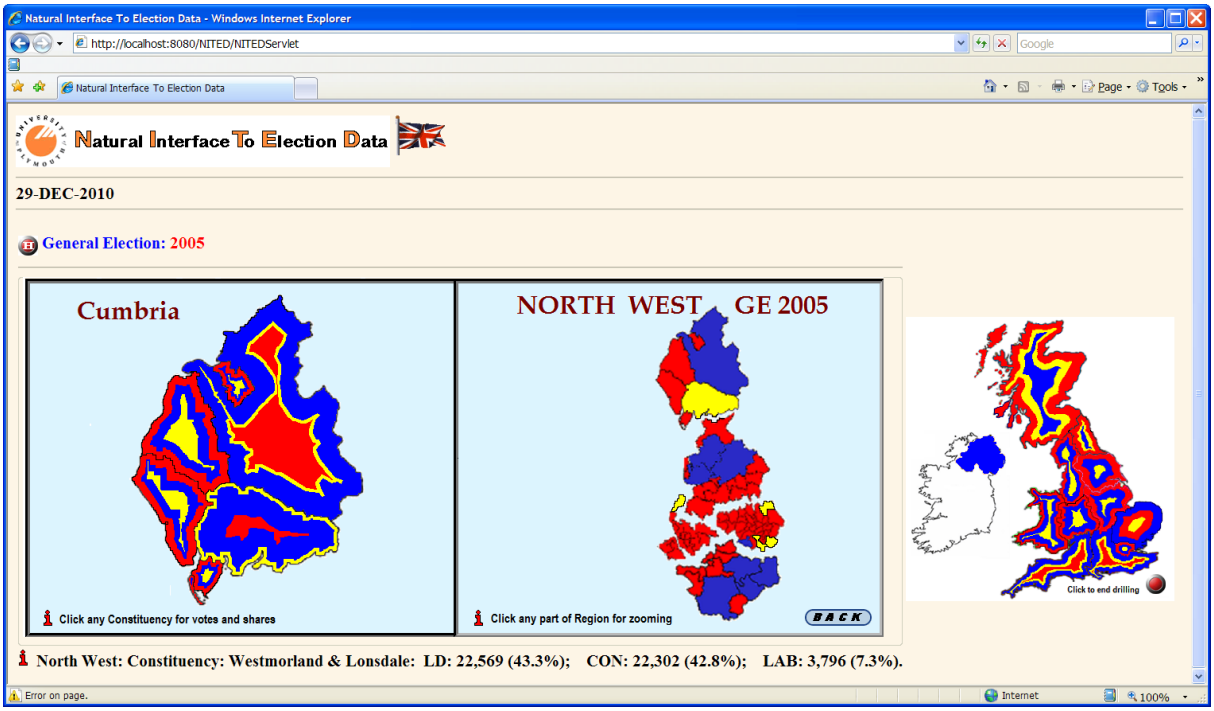


Figure 9. DD-Map of the GE 2005 for splitting of the North West region to Counties

As a result of clicking, for instance, the North West region DD-Maps of different levels will be displayed (see Figure 8). The North West region is sub-dividing into five Counties and then each County will be disaggregating to the different Constituencies. Clicking on any DD-Map of region (Figure 8) the next level of DD-Map will be displayed (see Figure 9). Finally, after clicking any specific constituency the result of election for that constituency will be shown.

Drill Down Map Creation

The well established **G**eographic **I**nformation computer-based **S**ystem (**GIS**) for mapping cannot be used to produce a DD-Map. The explanation for this is very simple. **Buffering feature** usually creates two areas: one area that is **within** a specified distance to selected real world features and the other area that is **beyond**. The area that is within the specified distance is called the **buffer zone.** A buffer distance always has to be defined as a whole number (integer) or a decimal number (floating point value). This value is defined in map units (meters, feet, decimal degrees) according to the Coordinate Reference System (CRS) of the vector layer.

There are three main reasons why GIS cannot be used to create DD-Map:

1. The GIS produce the buffer zone around the given centre point (i.e. building, town, river etc.).
2. A buffer distance has to be defined precisely for buffer zone producing.
3. The direction of DD-Map creation is from Region (or Constituency) border to centre and distance cannot be calculated explicitly.

Let's describe the operation of our algorithm for creating a DD-Map using real data:

GE 2010: Region: **London**, Constituency: **Harrow East**

Results: **CON: 21,435** **LAB: 18,032** **LD: 6,850**

Step 1. Calculate the percentage of votes with regard to maximum vote:

CON: 21,435 – **100%**

LAB: 18,032 – **84%** = 18032 / 21435 * 100

Step 2. Extract constituency from the Region London map using the Paint tool. Each Windows based computer has this tool along with Notepad, Word, Access etc. The square of image corresponds to 21,435 (or 100%). Let's call it **main image** and fill it with blue colour.

Step 3. Using the Paint (see Figure 10) stretch image to 84% and change the colour to red. Now the square of image corresponds to 18,032 (or 84%)

Step 4. Using the Paint, copy and paste the stretched image in the centre of the main image.

Step 5. Using the Paint stretch "blue" image to 32% (or "red" image to 38%) and change colour to yellow. Now the square of image corresponds to 6,850 (or 32% (38%))

Step 6. Using the Paint copy and paste the stretched image in the centre of previous main image and then place the mail image in Region's image.

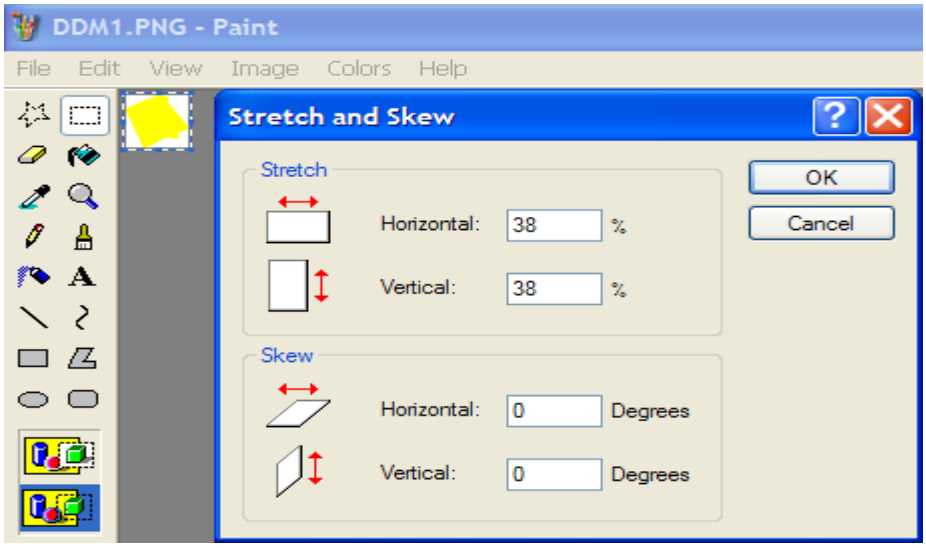


Figure 10. Using Paint to Stretch image

Drill Down Maps Examples

The next set of Figures are used to illustrate how the various mapping approaches can affect how we visualize the election results and what information the user can thereby perceive. This is especially true if you have no prior knowledge of the area being mapped; context is very important for visualization. Let us consider a drilling down of the London region for the 2005 parliamentary election.

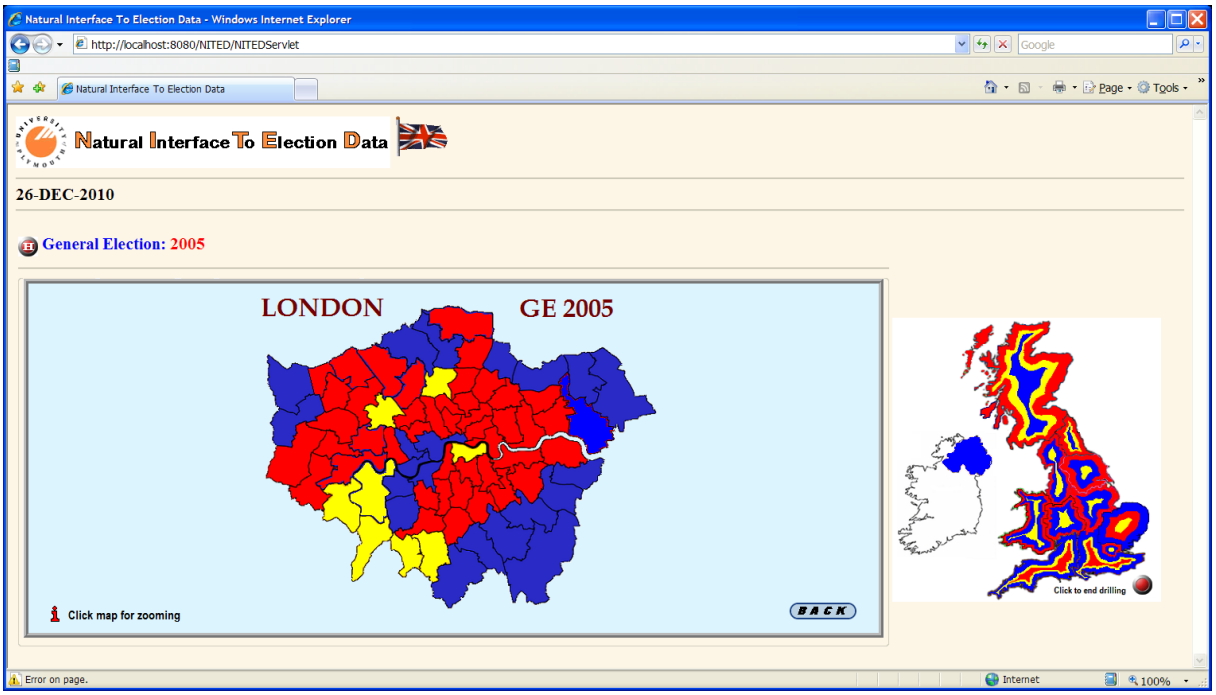


Figure 11. Constituencies Map of winner in London region

0-Level of London DD-Map (LDD-Map**0**) is shown in Figure 6 and indicates that Labour received the maximum votes. LDD-Map**1** from Figure 7 shows that Labour did not win the absolute number of votes:

London: LAB: 1,135,687 (38.9%) CON: 931,966 (31.9%) LD: 638,533 (21.9%)

LDD-Map**2** from Figure 11 shows the winner in each Constituency. For further drilling down the London region is sub-divided into four parts: North West (NW), North East (NE), South West (SW), and South East (SE). LDD-Map**3** for each of this part is shown in Figures 12-15. To see LDD-Map**3** for any particular part of the London region it is sufficient simply to click this part. Mouse click on any constituency of LDD-Map**3** immediately display the votes in that constituency.

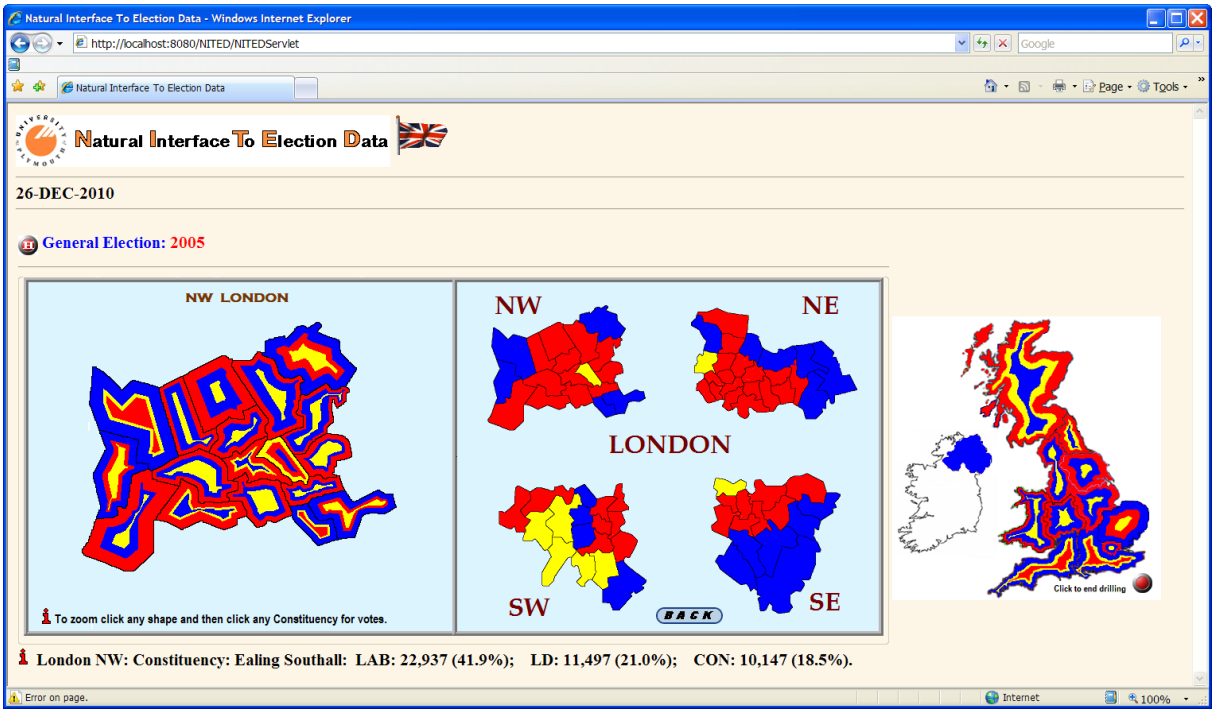


Figure 12. DD-Map of the GE 2005 for the NW part of London

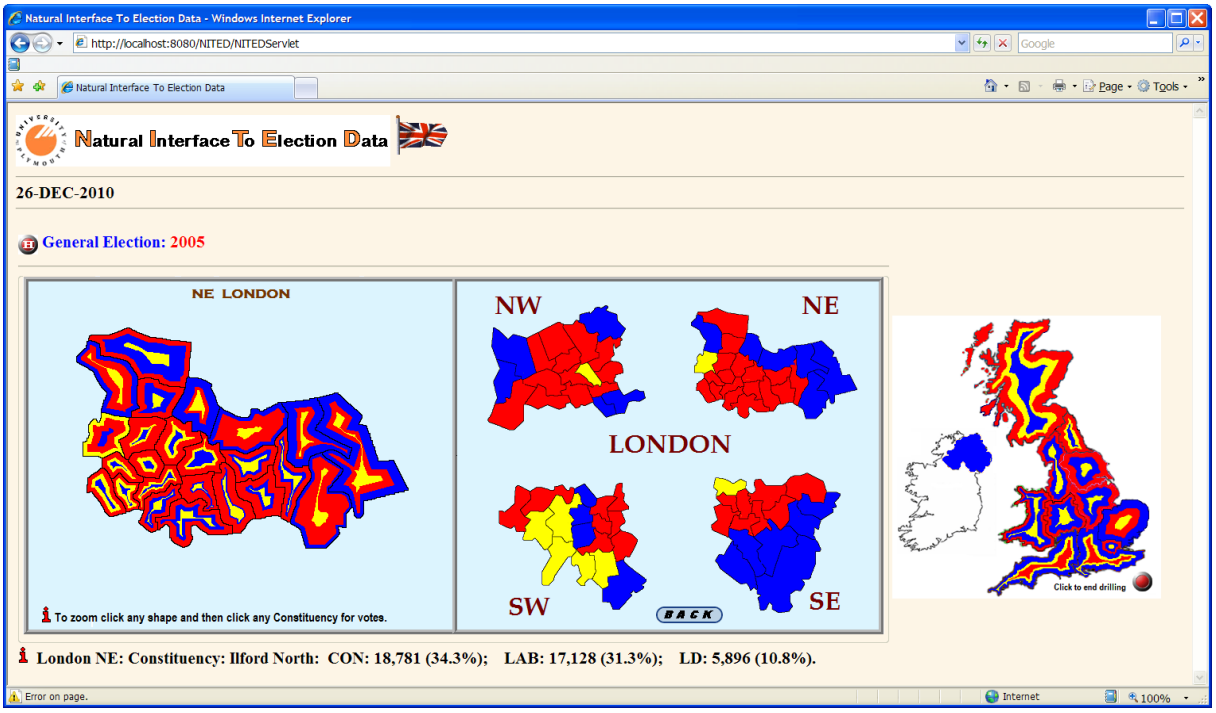


Figure 13. DD-Map of the GE 2005 for the NE part of London

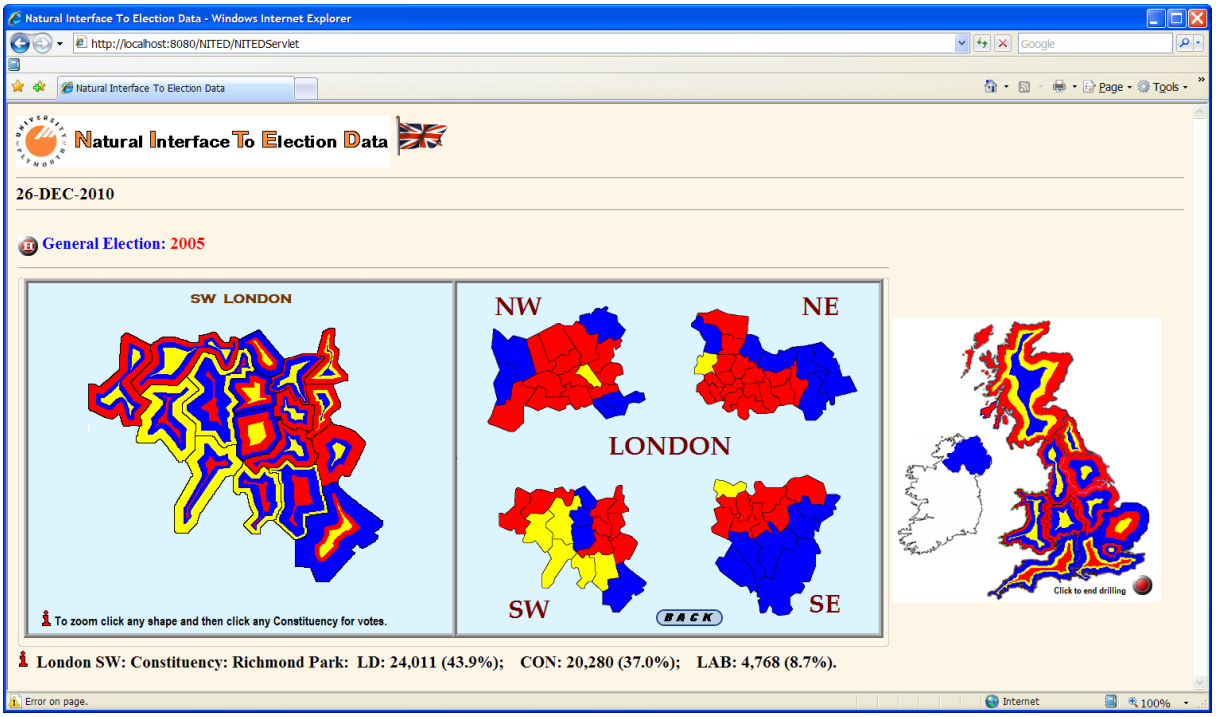


Figure 14. DD-Map of the GE 2005 for the SW part of London

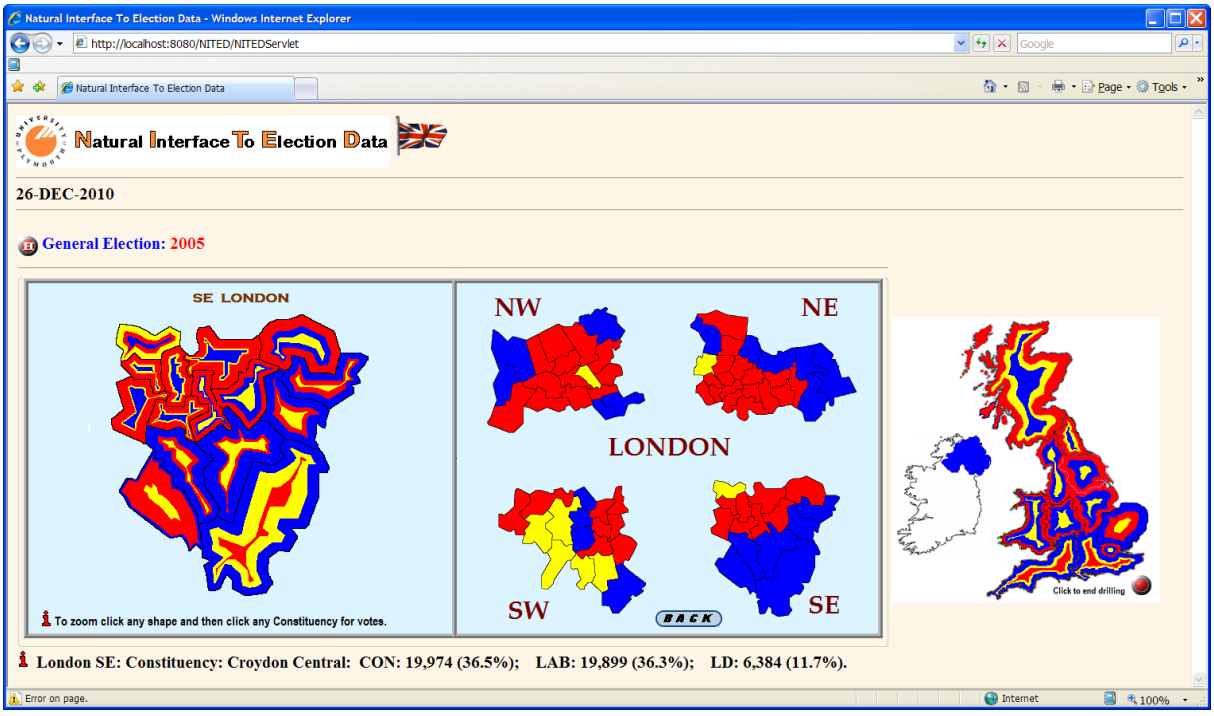


Figure 15. DD-Map of the GE 2005 for the SE part of London

Conclusion

We believe that Internet-based visualization of election results is and will continue to be very important because it facilitates user-interaction and engagement with the democratic process. NITED is designed through the Internet to make UK parliamentary election results available to any user, not simply those that possess relatively sophisticated knowledge about voting systems and their operation. Many users like to examine tables, charts, maps and DD-Maps to analyze election results. It is therefore very crucial that the Internet mass media provide visualizations that are accurate, user-friendly, and clear. We believe that NITED has the potential to encourage more people to engage with the political process.

Data, that is increasingly freely-available to end-users, lies at the heart of the modern world. Despite living in the information age, there is only so much information one person can handle at a given time. We are therefore fortunate that this is the digital information age, allowing computers to assist in translating vast quantities of data into a more usable form – away from tabular data and towards visualized data. Nevertheless, tables that come from querying databases are precisely what is used to create these visualizations. Furthermore, we have also designed some simple alternative visualization (DD-Maps) that are able to convey the same information much more clearly.

In future research we are planning to use visualization of election data for comparative analysis, thereby permitting users to visualize the dynamics of electoral change (see Fig.16).

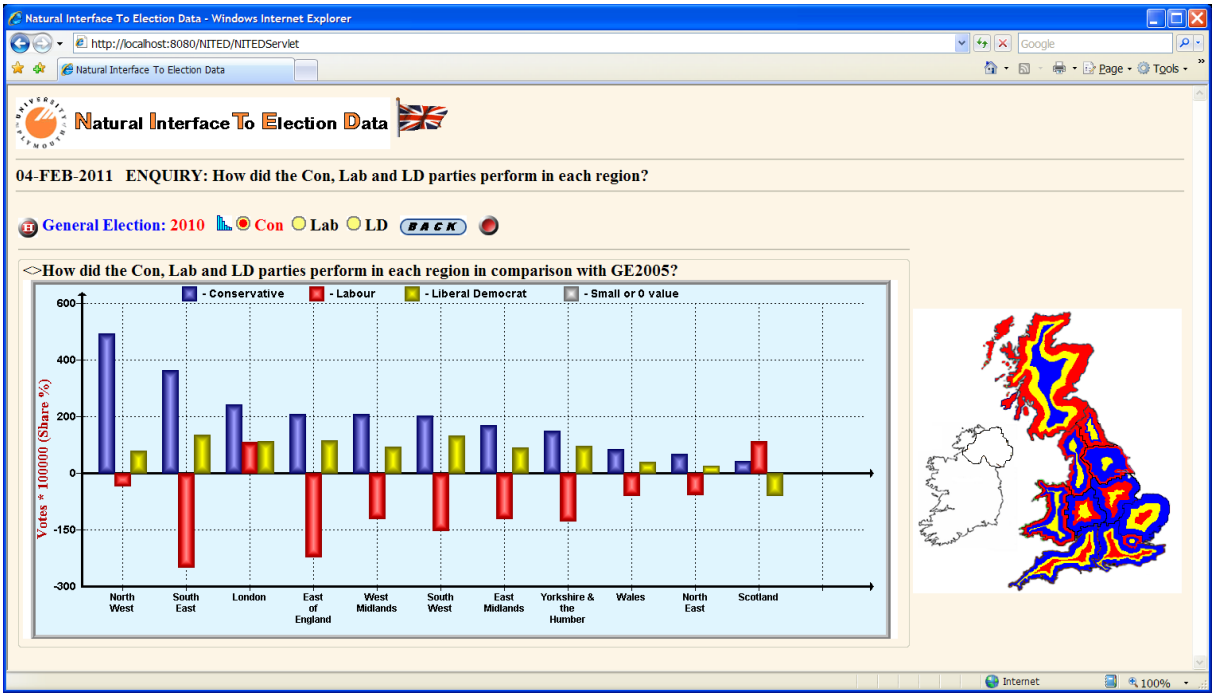


Figure 16. Comparison Analysis of GE2005/GE2010 results for Regions

Bibliography

C. Ware, 2000. Information Visualization: Perception for Design. Morgan Kaufman, San Francisco, CA

Guy Francis, Mark Lishman, Vladimir Lovitskii, Michael Thrasher, David Traynor, 2007. "Instantaneous Database Access", *International Journal "Information Theories & Applications", Vol 14(2)*, 161-168.

Elena Long, Vladimir Lovitskii, Michael Thrasher, David Traynor, 2009. "Mobile Election", International Book Series *"Information Science and Computing"*, Book 9, *Intelligent Processing*, 19-28.

Elena Long, Vladimir Lovitskii, Michael Thrasher, 2010. "Natural Interface to Election Data, International Book *"New Trends in Classification and Data Mining"*, ITHEA, Sofia, Bulgaria, 2010, 138-146.

S. K. Card, J. Mackinlay, and B. Shneiderman, 1999. Readings in Information Visualization, Using Visualization to Think, chapter 1, pages 1–34. Morgan Kaufmann.

S. Card, 2003. Information visualization. In J. A. Jacko and A. Sears, editors, The Human-Computer Interaction

Handbook: Fundamentals, Evolving Technologies and Emerging Applications, chapter 28, pages 544–582. Lawrence Erlbaum Associates, Mahwah, NJ.

Stephen L. Sperry, 2006, http://proceedings.esri.com/library/userconf/serug06/papers/rep_dem.pdf

V.A.Lovitskii and K.Wittamore, 1997. "DANIL: Databases Access using a Natural Interface Language", P*roc. of the International Joint Conference on Knowledge-Dialogue-Solution: KDS-97*, Yalta (Ukraine), 282-288.

Authors information

Elena Long *– University of Plymouth, Plymouth, Devon, PL4 6DX, UK,*

e-mail: elena.long@plymouth.ac.uk

Major Fields of Scientific Research: Data visualization in Political science

Vladimir Lovitskii *– University of Plymouth, Plymouth, Devon, PL4 6DX, UK,*

e-mail: vladimir.lovitskii@fsmail.net.

Major Fields of Scientific Research: Artificial Intelligence

Michael Thrasher*– University of Plymouth, Plymouth, Devon, PL4 6DX, UK,*

e-mail: mthrasher@plymouth.ac.uk

Major Fields of Scientific Research: Electoral analysis

TABLE OF CONTENTS