Problem of Simplicity -Complexity in Modern Science and Polymetrical Analysis

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Abstract. **Problem of simplicity – complexity in modern science is discussed. This problem is connected with creation of optimal system of knowledge. Historical comparative analysis of various system of knowledge is represented. The problem of complexity in modern cybernetics (problem of century according by S. Beer) and problems of complexity in computing science and mathematics are analyzed. Two aspects of problem simplicity complexity: system and computing are discussed. Necessity of creation of polymetric analysis as variant of full resolution this problem is discussed. It was shown that polymetric analysis is the answer on the resolution the problem simplicity-complexity in modern science and it is the universal system of analysis, synthesis and formalization of all possible chapters of knowledge. Perspectives of development and application of polymetric analysis are discussed too.**

Index Terms **– informative calculations, polymetric analysis, problem of century in cybernetics, problem simplicity-complexity.**

I. Introduction

Problem simplicity-complexity is central problem for each science [1]. Roughly speaking it is the problem of optimal formalization of knowledge.

Therefore this problem is basic for the creation new science. It was used by Aristotle, Descartes, Newton and other researches [1 – 4].

So problem of complexity is one of central problem in modern mathematics and cybernetics [1 – 5]. This problem is one of basic in synthetically sciences. Roughly speaking it has two aspects: system (problem of century in cybernetics according S. Beer [1,5]) and computing science (problem of computational complexity [1 – 4, 6]. Last problem is included in basic problems of modern mathematics (Smale problems) [1, 7].

As variant of resolution system aspect of problem complexity in cybernetics may be problem simplicity – complexity, which is included in Polymetric Analysis (PA) (universal system of analysis, synthesis and formalization of knowledge) as principle simplicity.

Hybrid theory of systems (HTS) as element of PA is created on the basis principles (criteria) of reciprocity and simplicity [1–4, 8, 9]. Only 10 minimal types of formalization system may be used. But number of real systems may be infinite. These systems are differed by step of its complexity. It is may be represented as answer on the one of basic question of modern theory of systems [1, 10, 11] about possible number of systems and its classification with point of simplicity – complexity [1–4, 8, 9].

Therefore HTS may be represented as variant of resolution the problem of century in cybernetics according S. Beer and may be used for the resolution problem of computational complexity (theory of informative calculations) [1, 3–6].

Theory of informative calculations may be represented as variant of resolution of computational complexity [1–4, 6, 8, 9].

Applications methods of PA for the creation polymetric theory of measure and measurements, generalizing econometrics and theory of functional logical automata are discussed too [1].

II. Short Historical Analysis of Problem Simplicity – Complexity

A problem of simplicity – complexity in modern knowledge and science is connected with problem of creation optimal system of knowledge.

In ancient times this problem was resolved about esoteric system of knowledge. So Egyptian Table of God of wisdom Thot (eight element system with God Thot controlling) is included mathematics, linguistics and ability to cultivate the soil [1, 12].

Mathematical and linguistically part of this Table was decoded with help the methods of modern information theory. The basic idea of this decoding is represented on Fig. 1 as functional linguistically schema [1].

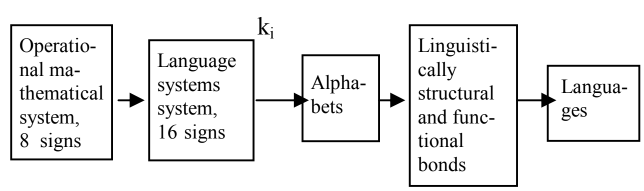

Figure 1. Functional linguistically schema.

Minimal operational computational system has 8 signs: four numbers and four mathematical operations (addition, subtraction, multiplication and division). For the group of two person this system must be has 16 signs. Set of many persons mast be has k_i16 signs, where k_i is the coefficient of informative surpluses. Minimal value of this coefficient is equaled 1,4 and therefore k_i16=22,4. This number is corresponded to number of letters in ancient Egyptian, Phoenician, Hebrew and Arabian alphabets [1]. Further expansion of this schema must be used linguistically structural and functional bonds and laws. Value of coefficient of informative surpluses 1,618 (gold proportion) is

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corresponded k_i16=25,888. This number is corresponded to number of letters in Latin and Greece alphabets. Other value of coefficients of informative surpluses are corresponded more as 1,618 are corresponded another languages. This schema may be used for the creation comparative linguistically programs for the research various languages and

Next step in the development of concept simplicity – complexity in modern science is connected with period of antiquity. Pythagor and his school synthesized in one system Egyptian (esoteric) and Sumerian (open) mythological systems, which is included mathematics, medicine and astrology [1, 12]. Aristotelian classification of knowledge and science was beginning of modern science. Euclidean "Principles" is one basis books of modern mathematics. Platonian three types numbers: mathematical, sensitive and ideal are corresponded to pure mathematics, applied mathematics and numerology in modern science [1].

In the Middle Ages the main study should be divided into three parts: research tied to monadology (J. Dee, N. Kuzansky, J. Bruno, W. Leubniz) [9], observations tied to the creation of synthetic theories (R. Bacon, R. Descartes, F. Bacon, I. Newton) [1] and research tied to the creation of the universal principles of optimality (P. Ferma, I. Bernulli, I. Newton, W. Leubniz) [1]. The last direction of researches was developed by P. Maupertui, L. Euler, J.L. Lagrange, R. W. Hamilton, R. Clausius, K. E. Shennon, I Prigozhin in XVII – XX centuries [1, 13 – 15].

Ideas of second and third parts were realized for the creation Lagrange formalism of Quantum Mechanics, theory of electroweak interactions, grand unification theory, cybernetics and other [1].

Number and measure was basic in mathematics from Euclides to Euler [1].

Short representation of this concept may be represented with help Newtonian four rules of conclusions in physics [16]:

Rule 1. Do not require the nature of other causes than those who are true and sufficient to explain the phenomena.

This is nothing but a criterion of optimal informative calculations of simplicity (see chapter IV of this paper).

Rule 2. Therefore, as far as possible, the same reason we should attribute displays the same kind of nature.

Roughly speaking this rule is a criterion of similarity in the most general terms. It is easy to see that he is more general theorem of similarity, because not tied to mathematical formalism. In our case it enters the criteria of reciprocity and simplicitly in another form (see chapter IV of this paper).

Rule 3. Such properties of bodies that can not be either amplified or unfasten and which are all bodies over which you can do the test shall be considered by the general properties of all bodies.

There is practically solved the problem of establishing invariants or laws that set the inductive method. It also implicitly included the criteria of reciprocity and simplicity (see chapter IV of this paper).

Rule 4. In experimental philosophy, propositions derived from phenomena through a common induction should be considered for exact or approximate correct, despite the possibility of conflicting hypotheses them until there are phenomena that they are even more précised or are found to be unreal.

It is inductive principle, which included as a particular case to the criterion of simplicity (see chapter IV of this paper).

Nature of mathematics is the analysis, synthesis and formalization of all possible knowledge. This concept was formulated by Ch. Volf (1716) [1]: "Mathematics is science to measure everything that can be measured. Of course it described as the science of numbers, the science of value, i.e. the things that might increase or decrease. Since all finite things can be measured in all that they have a finite, that is what they are, then nothing is, what can not be applied math, and because you can not have any more precise knowledge than when properties of things can be measured, the math leads us to the most perfect knowledge of all possible things in the world".

The concept of mathematical (measured) value was formulated student by Euler [1]:

1. First of all the known value that can increase or decrease…

2. There are many different kinds of values that are not exposed to calculate, and they come from different branches of mathematics, each of which has to do with their native values. Mathematics in general case is nothing but the science of values, dealing with finding ways of how to measure past.

3. However, it is impossible to determine whether a measured value except as known to take as another value of the same type and value set, which it is for her.

4. In determining whether any kind of measurement values so we come to what is known primarily established certain quantity of the same kind, called the measure or unit and depends solely on our choice. Then determined, in what respect is the appropriate value to the extent that it is always expressed in numbers. Thus measurement is no more than an attitude, which is one size to another, taken as a unit.

These provisions also formed the basis of the philosophical concept of Immanuel Kant [1], which is inextricably linked to science and mathematics degree. Every science begins with measurement and estimation. From this perspective, the foundation of mathematics is almost no one considers there is also strict mathematical theory. In objective approach mathematics should be seen not only as a theory of operations and transformations in a particular set of elements, but also as a tool for quantitative and qualitative assessment, modeling and prediction of phenomena and processes.

In the natural approach of foundation of mathematics the process of formalization or not considered or treated in a somewhat simplified implicitly. Therefore, it is natural that there was also the question of formalizing the process of formalization. In parallel to developing mathematics formal logic was developed [1, 17, 18]. This science was founded by Aristotle rightly considered. His "Organon" and now not only has historical significance for the science. It is designed deductive logic. Inductive logic almost two millennia have been designed by Francis Bacon. His "New Organon" perfectly complements the book of Aristotle. One of the founders of modern mathematical analysis (integral-differential calculus) W. Leubniz working on the problem of creating a universal calculus, came to the conclusion to synthesis of logic and mathematics [1]. In XVIII-th century this program was developed further by Condillac. However, only in the nineteenth century Morgan, Boole, Frege and Peano [1, 17] created mathematical logic. A.N. Whitehead and B. Russel on the basis of logic created the foundations of mathematics [1, 18]. This was the beginning of a structural approach to the fundamentals of mathematics. "Credo" logical concept is as follows [1, 17, 18]: mathematics – is part of the logic [17, 18]. However, the program encountered paradoxes inter-hierarchy type (Russell's paradox) and A.Puankare showed that axiom reduction relates not only to mathematics, what was the opinion of B. Russel [1, 17].

In a further development of modern mathematics are strongly affected by the following results of logistic direction [1, 17]

1. Logical concept had a crucial role in the development and justification of mathematical logic.

2. This concept helped establish the fact that the axiomatic method can accurately apply only within mathematical logic.

3. Principia Mathematica was the first attempt to create a unified math.

Formal (formalist) approach in the foundations of mathematics (school of proof theory) was developed by D.Hilbert and P.Bernayse [1, 19, 20], but it also took paradoxes inter-hierachy type. This program is the first place any mathematical theory that has some practical value, such as arithmetic. Then there is a formal system that meets the specific theory and expresses it. At the last stage of the chain ends metatheory, that deals with the formal system. The first who showed the futility of this trend for the foundations of mathematics was K. Gedel [17]. His incompleteness theorem showed the impossibility of describing a mathematical theory of permanent measure (mathematical logic and Kantor set theory) all the basic laws of mathematics. Later American mathematician P. Kohan showed independence axiom of selection (constructive axiom) from other axioms of mathematics [17].

The structural (intuitive) concept in the fundamentals of mathematics (in the Brauer-Heyting) [21, 22] do not give universal theory too. The main thesis of Heiting constructivism is the following [21]: "The goal, which poses a mathematician is next. He wants to do math as a natural function of the intellect as free live active thinking. Mathematics for he is a product of the human mind. The language of both conventional and formal, it applies only to messages that interest to others or himself to his mathematical analysis of opinion... At it is a core mathematical subject... due to human thinking. They exist only to the degree to which they can be identified thinking, and have only the properties, as they can be known of thinking." Not all agree with intuitionist Heyting [17, 22]. Overall intuitionism based on the following principles: the subject of mathematics can be only that consciousness can be built on the basis of certain well-defined basic intuitive representations. This implies that the number of math in constructive mathematics practically infinite and nothing to "to take up" to infinity this could work. That is a constructive approach in this sense also applies to the structural approach in the foundations of mathematics.

Thus, as seen from the above brief analysis, structural approaches in the foundations of mathematics not are universal and can not therefore claim to be the most common approach in the foundations of mathematics. In mathematics it is the same intuitive necessary construction, strict and precise logic formalism. If one of these factors has the advantage that it leads to the destruction of mathematics [1, 17].

But in XIX – XX centuries, foundations of mathematics were called problems, which is based one aspect of nature mathematics.

One of founder of logical concept A. N. Whitehead gave up his views in favor of the “organism” concept [23].

The concept, which may be represented foundation of mathematics or science in R. Bacon – Descartian concept, must be open system [1 – 4].

III. Problem of Complexity in Cybernetics, Computing Science and Mathematics

We begin this chapter from phrase by S. Beer [5]: “Apparently, the complexity becomes the problem of the century, just as the ability to process natural materials has been a problem of life and death for our forefathers. Our tool must be computers, and their efficiency should be provided by science, able to handle large and complex systems of probabilistic nature. This science may be cybernetics - the science of management processes and communication. The basic thesis of cybernetics can be set forth as follows: there are natural laws behavior of the large multibonds systems of any character submits that – biological, technical, special and economic.” But nature of some problems may be nonprobalistic too. Therefore this problem must be expanded on problem of formalization of all science and knowledge. But modern science is the realization of the R. Bacon – Descartian concept “Science is so science, how many mathematics is in her” [1, 24]. Development of modern science practically isn’t possible without computers.

Computational complexity theory [6] is a branch of the theory of computation in theoretical computer science that focuses on classifying computational problems according to their inherent difficulty, and relating those classes to each other. A computational problem is understood to be a task that is in principle amenable to being solved by a computer, which is equivalent to stating that the problem may be solved by mechanical application of mathematical steps, such as an algorithm. Basic problem of computing complexity is connected with polynomial calculations.

Computational complexity is a concept in computer science and theory of algorithms, depending on the function of indicating the volume of work that is performed by some algorithm, the size of the input data [6]. The section studies the computational complexity, called the theory of computational complexity. The volume of work is usually measured by abstract concepts of time and space, called computational resources. The time is determined by the number of elementary steps needed to solve the problem, while the space defined by memory capacity, or space on the storage medium.

A problem is regarded as inherently difficult if its solution requires significant resources, whatever the algorithm used. The theory formalizes this intuition, by introducing mathematical models of computation to study these problems and quantifying the amount of resources needed to solve them, such as time and storage. Other complexity measures are also used, such as the amount of communication (used in communication complexity), the number of gates in a circuit (used in circuit complexity) and the number of processors (used in parallel computing). One of the roles of computational complexity theory is to determine the practical limits on what computers can and cannot do [1, 6].

Closely related fields in theoretical computer science are analysis of algorithms and computability theory. A key distinction between analysis of algorithms and computational complexity theory is that the former is devoted to analyzing the amount of resources needed by a particular algorithm to solve a problem, whereas the latter asks a more general question about all possible algorithms that could be used to solve the same problem. More precisely, it tries to classify problems that can or cannot be solved with appropriately restricted resources. In turn, imposing restrictions on the available resources is what distinguishes computational complexity from computability theory: the latter theory asks what kind of problems can, in principle, be solved algorithmically.

The question why the concept of computational complexity is hard for the verifiable mathematics was discussed by J. Hromkoviĉ [25]. Therefore we must expand this problem on all science with help system with variable hierarchy or variable measure.

IV. Basic Concepts of Polymetric Analysis

Polymetric analysis (PA) was created as alternative optimal concept to logical, formal and constructive conceptions of modern mathematics and theory of information [1, 2]. This concept is based on the idea of triple minimum: mathematical, methodological and concrete scientific [1, 2].

However, one of the main tasks of polymetric analysis is the problem of simplicity-complexity that arises when creating or solving a particular problem or science. It must be open system [26].

In methodological sense, PA is the synthesis of Archimedes thesis: "Give me a fulcrum and I will move the world", and S.Beer idea about what complexity is a problem in cybernetics century, in one system. And as cybernetics is a synthetic science, the problem should be transferred and for all of modern science. Basic elements of this theory and their bonds with other science are represented in Figure 2 [1].

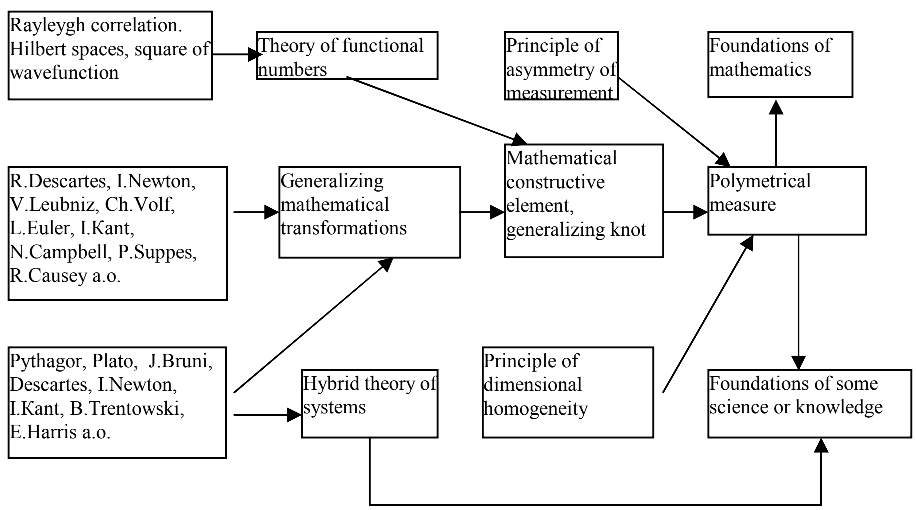

Figure 2. Schema of polymetric method and its place in modern science [1].

The polymetric analysis may be represented as universal theory of synthesis in Descartian sense. For resolution of this problem we must select basic notions and concepts, which are corresponded to optimal basic three directions of Figure 2. The universal simple value is unit symbol, but this symbol must be connected with calculation. Therefore it must be number. For the compositions of these symbols (numbers) in one system we must use system control and operations (mathematical operations or transformations). After this procedure we received the proper measure, which is corresponding system of knowledge and science.

Therefore the basic axiomatic of the polymetric analysis is was selected in the next form [1]. This form is corresponded to schema of Figure 2.

Definition 1. **Mathematical construction** is called set all possible elements, operations and transformations for resolution corresponding problem. The basic functional elements of this construction are called constructive elements.

Definition 2. The mathematical constructive elements $N_{x_{ij}}$ are called **the functional parameters**

$$N_{x_{ij}} = x_i \cdot \overline{x}_j , \qquad (1)$$

where x_i, $\overline{x_j}$ – the straight and opposite parameters, respectively; · - respective mathematical operation.

Definition 3 . The mathematical constructive elements $N_{\varphi_{ij}}$ are called the **functional numbers**

$$N_{\varphi_{ij}} = \varphi_i \quad \overline{\varphi}_j . \qquad (2)$$

Where $\varphi_i\left(x_1,...x_n,\overline{x_1}...\overline{x_m},...N_{x_{ij}}, \quad\right)$, $\overline{\varphi_j}\left(x_1,...x_n,\overline{x_1}...\overline{x_m},...N_{x_{ij}},...\right)$ are the straight and opposite functions, respectively; – respective mathematical operation.

Remark 1. Functions φ_I, $\overline{\varphi}_j$ may be have different nature: mathematical, linguistic and other.

Definition 4. The mathematical constructive elements $N^d_{x_{ij}}$ are called the **diagonal functional parameters**

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$$N^d_{x_{ij}} = \delta_{ij} N_{x_{ij}} . \quad (3)$$

Where δ_{ij} is Cronecker symbol.

Definition 5. The mathematical constructive elements $N^d_{\varphi_{ij}}$ are called the **diagonal functional numbers**

$$N^d_{\varphi_{ij}} = \delta_{ij} N_{\varphi_{ij}} . \quad (4)$$

Example 1. If $x_i = x^i$, $\overline{x}_j = x^{-j}$ and $\max\{i\} = \max\{j\} = m$, then $\{N^d_{\varphi_{ij}}\}$ is diagonal single matrix.

Another example may be the orthogonal eigenfunctions of the Hermitian operator.

Remark 2. These two examples illustrate why quantities (1) – (4) are called the parameters and numbers. Practically it is the simple formalization the measurable procedure in Fig.1 The straight functions correspond the "straight" observation and measurement and opposite functions correspond the "opposite" observation and measurement. This procedure is included in quantum mechanics the Hilbert's spaces and Hermitian operators.

The theory of generalizing mathematical transformations is created for works on functional numbers [1].

Definition 6. **Qualitative transformations** on functional numbers $N_{\varphi_{ij}}$ (straight A_i and opposite $\overline{A}_j$) are called the next transformations. The straight qualitative transformations are reduced the dimension $N_{\varphi_{ij}}$ on i units for straight parameters, and the opposite qualitative transformations are reduced the dimension $N_{\varphi_{ij}}$ on j units for opposite parameters.

Definition 7. **Quantitative (calculative) transformations** on functional numbers $N_{\varphi_{ij}}$ (straight O_k and opposite $\overline{O}_p$) are called the next transformations. The straight calculative trasformations are reduced $N_{\varphi_{ij}}$ or corresponding mathematical constructive element on k units its measure. The opposite quantitative transformations are increased $N_{\varphi_{ij}}$ or corresponding mathematical constructive element on l units its measure, i.e.

$$O_k \overline{O}_l N_{\varphi_{ij}} = N_{\varphi_{ij}} - k \oplus l . \quad (5)$$

Definition 8. **Left and right transformations** are called transformations which act on left or right part of functional number respectively.

Definition 9. The maximal possible number corresponding transformations is called **the rang of this transformation**

$$rang(A_i \overline{A}_j N_{\varphi_{ij}}) = \max(i, j); \quad (6)$$

$$rang(O_k \overline{O}_p N_{\varphi_{ij}}) = \max(k, p). \quad (7)$$

Remark 3. The indexes $i,j,$ k,p are called **the steps of the corresponding transformations.**

For this case we have finite number of generalizing transformations.

The basic types of generalizing mathematical transformations are represented in Table 1 [1].

Table 1. *The basic types of generalizing mathematical transformations.*

№	Tronsfor-mation	1	2	3	4	5	6	7	8	9	10	11	12	Representation		
														S	O	M
1	full straight	+	+	+	+	+	+	+	+	+	+	+	+	+	–	–
2	full opposite	+	+	+	+	+	+	+	+	+	+	+	+	-	+	–
3	full mixed	+	+	+	+	+	+	+	+	+	+	+	+	-	–	+
4	left full straight	+	-	+	–	+	-	+	–	+	–	+	–	–	+	–
5	right full opposite	–	+	–	+	–	+	–	+	–	+	–	+	+	–	–
6	left straight	+	–	+	–	+	–	+	–	+	–	+	–	+	–	–
7	right opposite	–	+	–	+	–	+	–	+	–	+	–	+	–	+	–
8	mixed full straight	+	-	+	–	+	–	+	–	+	–	+	–	–	–	+
9	mixed full opposite	–	+	–	+	–	+	–	+	–	+	–	+	–	–	+
10	left half-straight	+	–	–	+	–	+	+	–	–	+	–	+	–	+	–
11	mixed half-straight	+	–	–	+	–	+	+	–	–	–	–	–	–	–	+
12	right semi-opposite	–	+	+	–	+	–	–	+	+	–	+	–	+	–	–
13	mixed semi-opposite	–	+	+	-	+	–	–	+	+	–	+	–	–	–	+
14	mixed straight	+	–	+	–	+	–	+	+	+	+	+	+	–	–	+
15	mixed opposite	–	+	–	+	–	+	+	+	+	+	+	+	–	–	+

Remarks to Table 1. S – straight; O – opposite; M – мixed; 1 – A_i; 2 – $\overline{A}_j$; 3 – A^r; 4 – $\overline{A}^r$; 5 – A^l; 6 – $\overline{A}^l$; 7 – O_k; 8 – $\overline{O}_p$; 9 – O^r; 10 – $\overline{O}^r$; 11 – O^l; 12 – $\overline{O}^l$. In Table 1 sigh + (plus) is defined that action of corresponding transformation on $N_{\varphi_{ij}}$ is fully or particularly; sign (minus) – is absented.

Basic elements of PA is the generalizing mathematical elements or its various presentations – informative knots [1 – 4]. Generalizing mathematical element is the composition of functional numbers (generalizing quadratic forms, including complex numbers and functions) and generalizing mathematical transformations, which are acted on these functional numbers in whole or its elements [1]. Roughly speaking these elements are elements of functional matrixes.

This element ${}^{stqo}_{nmab}M_{ijkp}$ may be represented in next form

$${}^{stqo}_{nmab}M_{ijkp} = A_i \overline{A}_j O_k \overline{O}_p A^r_s \overline{A}^r_t O^r_q \overline{O}^r_o A^l_n \overline{A}^l_m O^l_a \overline{O}^l_b N_{\varphi_{ij}} . \quad (8)$$

Where $N_{\varphi_{ij}}$ – functional number; $O_k, O^r_q, O^l_a, \overline{O}_p, \overline{O}^r_o, \overline{O}^l_b$; $A_i, A^r_s, A^l_n, \overline{A}_j, \overline{A}^r_t, \overline{A}^l_m$ are quantitative and qualitative transformations, straight and inverse (with tilde), (r) – right and (l) – left.

Polyfunctional matrix, which is constructed on elements (17) is called informative lattice. For this case generalizing mathematical element was called knot of informative lattice [1 – 4]. Informative lattice is basic set of theory of informative calculations. This theory was constructed analogously to the analytical mechanics [1].

Basic elements of this theory are [1 – 4]:

1. Informative computability C is number of possible mathematical operations, which are required for the resolution of proper problem.

2. Technical informative computability $C_t = C\sum t_i$, where t_i – realization time of proper computation.

3. Generalizing technical informative computability $C_{t0} = k_{ac}C_t$, where k_{ac} – a coefficient of algorithmic complexity [1].

Basic principle of this theory is **the principle of optimal informative calculations** [1 – 4]: any algebraic, including constructive, informative problem has optimal resolution for minimum informative computability C, technical informative computability C_t or generalizing technical informative computability C_{to}.

The principle of optimal informative calculations is analogous to action and entropy (second law of thermodynamics) principles in physics.

The principle of optimal informative calculation is more general than **negentropic principle the theory of the information** and **Shennon theorem** [1, 13 – 15]. This principle is law of the open systems or systems with variable hierarchy. The negenthropic principle and Shennon theorem are the principles of systems with constant hierarchy.

Idea of this principle of optimal informative calculation may be explained on the basis de Broglie formula [1,2, 15]

$$S_a/\hbar = S_e/k_B \qquad (9)$$

(equivalence of quantity of ordered and disorder information) [1,5]. Where S_a – action, $\hbar$ – Planck constant, S_e – entropy and k_B – Boltzman constant. Therefore we can go from dimensional quantities (action and entropy) to undimensional quantity – number of proper quanta or after generalization to number of mathematical operations. Thus, theory of informative calculations may be represented as numerical generalization of classical theory of information.

For classification the computations on informative lattices hybrid theory of systems was created [1]. This theory allow to analyze proper system with point of view of its complexity,

The basic principles of hybrid theory of systems are next: 1) **the criterion of reciprocity;** 2) **the criterion of simplicity**.

The criterion of reciprocity is the principle of the creation the corresponding mathematical constructive system (informative lattice). The criterion of simplicity is the principle the optimization of this creation.

The basic axiomatic of hybrid theory of systems is represented below.

Definition 10. The set of functional numbers and generalizing transformations together with principles reciprocity and simplicity (informative lattice) is called **the hybrid theory of systems** (in more narrow sense the criterion of the reciprocity and principle of optimal informative calculations).

Criterion of the reciprocity for corresponding systems is signed the conservation in these systems the next categories:

1) the completeness;
2) the equilibrium;
3) the equality of the number epistemological equivalent known and unknown knotions.

Criterion of the simplicity for corresponding systems is signed the conservation in these systems the next categories:

1) the completeness;
2) the equilibrium;
3) the principle of the optimal calculative transformations.

Criterion of reciprocity is the principle of creation of proper informative lattice. Basic elements of principle reciprocity are various nuances of completeness. Criterion of the simplicity is the principle of the optimality of this creation.

For more full formalization the all famous regions of knowledge and science the **parameter of connectedness σ_t** was introduced. This parameter is meant the number of different bounds the one element of mathematical construction with other elements of this construction. For example, in classic mathematics σ_t = 1, in linguistics and semiotics $\sigma_t > 1$. The parameter of connectedness is the basic element for synthesis in one system of formalization the all famous regions of knowledge and science. It is one of the basic elements for creation the theory of functional logical automata too.

Basic mathematical element of polymetric analysis is functional number (generalizing elements of square forms) [1]. As in Greece mathematics number is basic elements of its system. For these numbers generalizing mathematical transformations were constructed. 15 minimal types of its transformations are existed. Informative lattice is constructed on the basis if functional numbers and generalizing mathematical transformations. Theory of informative calculations is created for this lattice. Basic principle of this theory is the principle of optimal calculations.

For classification of systems of calculation hybrid theory of systems was created. This theory is based on two criterions: criterion of reciprocity – principle of creation of proper formal system, and criterion of simplicity – principle of optimality of this creation. For "inner" bond of two elements of informative lattice a parameter of connectedness σ_t was introduced. Principle of optimal informative calculation is included in criterion of simplicity.

At help these criteria of reciprocity and simplicity and parameter of connectedness the basic famous parts of knowledge and science may be represent as next 10 types of hybrid systems [1 – 4]:

1. The system with conservation all positions the criteria of reciprocity and simplicity for all elements of mathematical construction ($N_{\varphi_{ij}}$ and transformations) is called the *simple system.*

2. The system with conservation the criterion of simplicity only for $N_{\varphi_{ij}}$ is called the *parametric simple system.*

Remark 4. Further in this classification reminder of criteria of reciprocity and simplicity is absented. It mean that these criteria for next types of hybrid systems are true.

3. The system with conservation the criterion of simplicity only for general mathematical transformations is called *functional simple system.*

4. The system with nonconservation the principle of optimal informative calculation and with $\sigma_t = 1$ is called the *semisimple system*.

5. The system with nonconservation the principle of optimal informative calculation only for $N_{\varphi_{ij}}$ and with $\sigma_t = 1$ is called the *parametric semisimple system*.

6. The system with nonconservation the principle of optimal informative calculation only for general mathematical transformations and with $\sigma_t = 1$ is called the *functional semisimple system*.

7. The system with nonconservation the principle of optimal informative calculation and with $\sigma_t \neq 1$ is called *complicated system*.

8. The system with nonconservation the principle of optimal informative calculation only for $N_{\varphi_{ij}}$ is called *parametric complicated system*.

9. The system with nonconservation the principle of optimal informative calculation only for general mathematical transformations and with $\sigma_t \neq 1$ is called *functional complicated system*.

10. The system with nonconservation the criteriums of reciprocity and simplicity and with $\sigma_t \neq 1$ is called *absolute complicated system*.

With taking into account 15 basic types of generalized mathematical transformations we have 150 types of hybrid systems; practically 150 types of the formalization and modeling of knowledge and science.

Only first four types of hybrid systems may be considered as mathematical, last four types are not mathematically. Therefore HTS may be describing all possible system of knowledge. Problem of verbal and nonverbal systems of knowledge is controlled with help of types the mathematical transformations and parameter connectedness [1].

HTS may be used for the classification and creation old and new chapters of all science, including computing science.

HTS may be used for the represented of evolution of systems in two directions: 1) from simple system to complex system (example, from classic to quantum mechanics) and 2) conversely, from complex system to simple system (example, from formal logic to mathematical logic) [1].

Hybrid theory of systems is open theory. Parameters of openness are number of generalizing mathematical transformations and parameter of connectedness. Thereby we have finite number of types of systems, but number of systems may be infinite. Hybrid theory of systems allows considering verbal and nonverbal knowledge with one point of view [1 – 4, 22]. Therefore this theory may be represented as variant of resolution S. Beer centurial problem in cybernetics [1].

HTS may be represented as application PA (HTS) to the problem of calculation [1 – 4]. This theory was used for the problem of matrix computation and problem of arrays sorting [1, 4].

HTS may be connected with problem of computational complexity. This problem was appeared in modern cybernetics for resolution of problem the transition from infinite (analytical) to discrete representation of computing procedures [1, 3, 4]. In may be connected with 4 and 5 Smale problems [1, 7].

HTS may be used for the classification of knowledge and science with point of view of their complexity. These results may be represented as theorems [1].

Theorem 1. The classical mechanics is the simple system.

Proof. The classical mechanics is closed system therefore criteria of the reciprocity and simplicity are true. The action principle is the analogous the principle of optimal informative calculations. Parameter of connectedness is equal 1. But its definition of simple system and theorem is proved.

Theorem 2. The quantum mechanics is the semisimple system : 1) in Heisenberg's representation – parametric simple; 2) in Shrödinger's representation – functional simple; 3) in the representation of interaction – semisimple system.

Proof. The quantum mechanics is closed system as classical mechanics. But the criterion of the simplicity isn't true for operators (in Heisenberg's representation), for wave functions (in Shrödinger's representation) and for operators and wave functions (in representation of the interaction). Parameter of connectedness is equal 1 for all three representations. But it is the definitions of proper systems and theorem is proved.

Theorem 3. Logic is a simple system.

Proof. Logic is a closed system. Criteria for reciprocity and simplicity of the system implemented. Parameter connectivity is equaled one. Thus mathematical logic is a simple system that QED.

Theorem 4. Linguistics is a complex system.

Proof. Linguistics is semi-closed or open system. Criteria reciprocity and simplicity may not come true. Parameter connectivity, typically, is greater than one. But it is the definition of a complex system.

This theorems practically are represented the system character of the theoretical (classic) and quantum mechanics in modern science.

Once again we return to the foundations of mathematics. Classical mathematics is characterized by parameter of connectedness that is equal to one. It means that quite complex and sophisticated mathematical system is not mathematical in the classical sense. But the foundations of mathematics we have a theory with a broader subject base as classical mathematics (including mathematical logic and set theory). This theory is in our view should include formalizing the procedure (functional numbers and criteria of reciprocity and simplicity), process analysis and synthesis (qualitative and quantitative transformation) and the problem of uniqueness (parameter of connectedness). This theory is also essential to have provisions that take into account its opening from the system point of view. In polymetric analysis meet this requirement parameter of connectedness and possible failure of certain provisions of criteria of reciprocity and simplicity. The theories of «structural lines» in the foundations of mathematics do not meet these requirements. This provision can be formulated as the following theorem.

Theorem 5. The theory of "structural lines" in the foundations of mathematics (logical, formal and intuitive) can not be extended to all mathematics.

Proof. The theory of «structural lines» is permanent measures, while mathematics because of its development has a variable structure, and each structural element has its own measure. But metamathematycal theory must to be theory with variable measure. We got a contradiction and thus proved the theorem.

If we consider polymetric approach in terms of H. Kantor expression "The essence of mathematics lies in its freedom", this freedom is included in the variable measure.

Polymetric analysis may be represented as generalization of basic problem of cybernetics in Wiener sense "Cybernetics is the science of the Control and Communication in the Animal and the Machine" [27].

V. Basic Applications of Polymetric Analysis

Polymetric theory of masure and measurement is based on generalizing structural element (8) [1].

We need to (8) to link the measurement procedure. To do this, you must first set the type of system. For measurements in the classic sense of the word in this case functional numbers and quantitative transformations are correspond, because in fact they (quantitative transformations) responsible for arithmeticality the class intensities $\left(N_{\varphi_{ij}}\right)$, which is already very accurately speaking, is a measure. This corresponds to the theory of classical measure.

Qualitative transformation responsible: firstly, for the choice of a dimension of proper measurement; secondly, for the impact of possible errors and corrections on measurement results; thirdly, they are elements of simulation, prediction and assessment of an item of observation.

The criterion of reciprocity and the principle of optimal informative calculation are criteria of most advantageous mode of obtaining a particular result. Here, unlike the conventional measurement takes into account the dimension and choose the optimal ratio between the empirical and mathematical parts. This approach allows us to measure and predict them.

Now we consider in more detail what gives us the input of qualitative transformation. On the one hand it is a generalization of existing mathematical operations (integration, differentiation, etc.), and on the other hand it is a more powerful machine mathematical transformations.

We introduce several auxiliary concepts.

Definition 11. The transformation is called symmetric if rank direct and inverse transformations are equal.

In terms of the classical theory of measure the introducing straight and opposite transformations simply means an act performed measurements or not. In our case this is true only for quantitative transformations, and in the case of qualitative transformations is not. The fact that the symmetrical qualitative transformation can change the measure without changing its dimensions, that allow you to do izodimensional spectral decomposition of measure.

Qualitative transformation - a transformation without one or transformation with a single transformation to rank, ie,

$$\begin{aligned} \text{rang } A_i \cdot \overline{A}_i &= 0, \\ \text{rang } A_i \cdot \overline{A}_{i\pm 1} = \text{rang } \overline{A}_{i\pm 1} \cdot A_i &= \pm 1. \end{aligned} \tag{2.172}$$

This concept in contrast to the classical hierarchical approach allows consider the heterogeneous conditions of measurement and processing of measurement results for corresponding problems.

Now we will result in accordance with the theory of polymetric theory of measure. Purely measurement in the classical sense of the word is just a simple system. In all other types of systems we can get along with the measurement also estimates and projections, and in the case of quite complex systems - only forecasts.

The main criteria and principles of polymetric theory of measure and measurements can be part of our submission stated as follows.

The principle of asymmetry the measurement. When the measurement, including the result can, be expressed as (8), the fair value

$$\begin{aligned} &|k-p|\geq 1; \\ &|q-o|\geq 1; \\ &|a-b|\geq 1. \end{aligned} \tag{11}$$

Strictly speaking, it is enough to make it fair to at least one of the three relationships.

It is easy to see the relation (11) is the mathematical expression of the principle of asymmetry measurements for quantitative transformation is precisely the transformations that meet additive properties extent that they can act as "weight" and as "balance," and as a "calculator".

From the analysis dimension because of the above given constructive mathematics can be described by equations not required, so the most common result can be formulated in such a way:

The principle of dimensional homogeneity. When measuring procedure can be represented by (8), then the correct definition of the dimension of the measured values is necessary that the condition:

$$\begin{aligned} {}^{stqo}_{nmab}M_{ijkp} = \delta_{ij}(A_i,\overline{A}_j)\delta_{st}(A^r_s,\overline{A}^r_t)\delta_{nm}(A^l_n,\overline{A}^l_m)\times \\ \times O_k\overline{O}_p O^r_q \overline{O}^r_o O^l_a \overline{O}^l_b N_{\varphi_{ij}}, \end{aligned} \tag{12}$$

where $\delta_{ij}(A_i,\overline{A}_j);\delta_{st}(A^r_s,\overline{A}^r_t);\delta_{nm}(A^l_n,\overline{A}^l_m)$ – proper algebraic Kronecker symbols on corresponding transformations.

In general, the condition (2.174) can be represented in a more compact form:

$$\begin{aligned} {}^{stqo}_{nmab}M_{ijkp} = \delta_{i+s+n,j+t+m}\left(A_i,\overline{A}_j,A^r_s,\overline{A}^r_t,A^l_n,\overline{A}^l_m\right)\times \\ \times f\left(O_k,\overline{O}_p,O^r_q,\overline{O}^r_o,O^l_a,\overline{O}^l_b\right)N_{\varphi_{ij}} \end{aligned} \tag{12a}$$

where $\delta_{i+s+n,\, j+t+m}$ – summary algebraic Kronecker symbol.

It is easy to see that the ratio (12) and (12a) is a generalization of the principle of dimensional homogeneity.

Thus, from the above follows:

Definition 12. The theory is the theory polymetric measurements, if it based on a set of elements ${}^{stqo}_{nmab}M_{ijkp}$, which specified criteria of reciprocity and and just principles of asymmetry measurement and dimensional homogenity.

Polymetric theory of measure and measurement may be represented as optimal formalization N.R.Campbell concept [28, 29] about primary and derived measurements. N.R. Campbell concept is more general as "measuring" part of quantum mechanics [1,2]. Therefore L.I. Mandelstam called Quantum Mechanics as science of derivative measurements [1, 2].

Polymetric analysis is the system of optimal formalization, synthesis and analysis of knowledge. But it is the nature of mathematics [1, 17]. For creation of theory of foundations of mathematics we must include three aspects: synthesis, analysis and formalization. This theory must be open system. Therefore Russel – Whitehead “logic” concept, Hilbert – Bernayce “formal” concept and Brauer – Heiting “constructive” concept can’t be full theories of foundations of mathematics [1]. It was cause of crisis in theory of foundations of mathematics. Therefore A.N. Whitehead made conclusion that logical concept can’t be the theory of foundations of mathematics [1, 23]. But it must be “organismic” theory[23]. Practically this concept was realized in cybernetics: theory of neuronets, systolic computers, theory of cellular automata a.o. [1]. Therefore polymetric analysis may be represented as variant of realization of Whitehead concept of “organism” mathematics and formalizing unification of proper cybernetic theories (Ivakhnenko concept of neurosets itc.) [1, 30].

Attempt of association of all possible knowledge in one system on the number (arithmetical) basis was made by Platon: three types of numbers (arithmetical, sensitive and ideal). With modern point of view a arithmetical numbers are corresponded to modern pure mathematics; a sensitive numbers are corresponded to modern applied mathematics and ideal numbers are corresponded to other chapter of science and knowledge [1].

Polymetric analysis may be represented as optimal “dynamical” formalization of Errol E. Harris polyphasic concept of modern science [1, 2, 31].

Polymetric measure (generalizing knot of informative lattice) may be used in monadology as monada [9]. Only Leubniz considered monad as a universal first principle [9], J. Bruni considered monad as philosophical first principle only. Therefore polymetric analysis may be represented as formalization of Leubnizian monadology and variant resolution of second her problem: search and creation of universal calculation. This problem must be resolve with help methods of theory of open system. Roughly speaking, in Leubnizian terms, we must be uniting concept of monad with concept of creation of universal calculation.

Polymetric analysis may be represented as renewal ancient Egyptian and Pythagorean systems (only their computational part) [1]. It may be answer on question: why Egyptian and Greece mathematics managed without zero [1].

Thus basic concepts of awakening, creation and development of synthesis with including of historical analysis of this problem are represented in [1]. Therefore with this point of view polymetric analysis is the necessary development of problem of formalized synthesis in modern science.

According to A Ershov basic problem of modern computer science is formalization of phrase of Canadian philosopher L. Hall: “Everything comes from the head – intelligent” [1]. Therefore PA may be represented as optimal formalization of this thesis and, as effect, theoretical basis of modern computing science (informatics) [1,2].

PA was used for the formalization J. von Neumann concept od semireproducing automata. This theory was called functional logical automata [1]. It is mathematical theory but it is more general as theory of Quantum Computers because it includes various measures as basic elements. Roughly speaking this theory may be represented as application N.R. Campbell concept for the creation of automata theory.

Theory of informative physical structures is theory, which is based on the synthesis information theory and physics on level of its basic laws [1].

Polymetric analysis was used for the creation of generalizing econometrics. This theory is added and expanded Hiks laws of equilibrium econometrics [1].

The theory of diffeomorphism-conjugated forms is added to methods of classical integral-differential calculus [1].

Question about necessity of creation cybernetics as open system was formulated many researches [1, 10, 26, 32].

According to W.R. Asby the most fundamental concept of cybernetics is the concept of "differences", meaning that any two things significantly different or one thing has changed over time. The concept includes, of course, all the changes that may occur over time. After all, when the plants grow, the planet's age and cars are moving, there is always some variation of one state to another. Our first task will be to develop this notion of "change", not only updating, but also enriching it, giving it a form, which, as experience has shown, is required for in-depth study [32].

On the basis of this in [32], W.R. Ashby formulated his Law of Requisite Variety stating that "variety absorbs variety, defines the minimum number of states necessary for a controller to control a system of a given number of states." This law can be applied for example to the number of bits necessary in a digital computer to produce a required description or model.

This law has two modern interpretations and one exception for complex systems.

The first interpretation according to G. Bateson [33]: "Ross Ashby showed that no system (no computer, no body) can not produce anything new, if it does not in its composition some source of random. In the computer it will be a random number generator, which provides that the "search", the machine moves on a method of trial and error will eventually cover all possibilities of the test set."

The second interpretation: a variety of management systems must not be less diversity managed object. This interpretation is close previously obtained conclusions of Claude Shannon [14] that the capacity of a communication channel should not be less diversity signal ...

The Law of Requisite Variety by W.R. Ashby is not fulfilled if we are talking about the destruction of the complex structure.

The PA may be used for this problem in the next way. This theory is theory with variable hierarchy or open systems. Therefore the Law of Requisite Variety may be formulated as the problem of the concept of "differences" within the system with a permanent hierarchy and a system with variable hierarchy. Hierarchy of system may be changed with help generalizing mathematical transformations, the step of its complexity and parameter of connectedness.

Law of Requisite Variety may be received with criteria of reciprocity and simplicity.

VI. Conclusions

- The problem of simplicity – complexity in modern science is discussed.
- Short historical analysis of this problem is represented.
- Problems of complexity in modern cybernetics, computer science and mathematics are analyzed.

- Necessity of creation universal theory for resolution of problem simplicity – complexity in modern science is shown.
- Basic structure of PA (functional numbers, generalizing mathematical transformations, informative lattice, theory of informative calculations, hybrid theory of systems, polymetric theory of measure and measurement) are represented.
- Basic applications of PA for the resolution of some problems of modern cybernetics and computer science (the problem of the twentieth century Beer in cybernetics by S. Beer, unsolved problems in the theory of algorithms, 5-th Smale problem) are represented.
- The questions about the presentation PA as natural concept of foundations mathematics and foundation of science in Descartian sense are analyzed.
- It shown that PA may be represented as universal system of controlling and management in modern science.
- Applications methods of PA for the creation polymetric theory of measure and measurements, generalizing econometrics, theory of functional logical automata and for the resolution some synthesized problems of modern science are discussed too.

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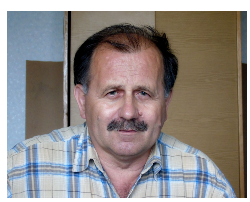

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