

GENETIC FORESIGHT IN SCIENCE AND TECHNOLOGY: FROM GENETIC CODE TO INNOVATIVE PROJECTS

V. Shynkarenko

National Technical University of Ukraine “Kyiv Polytechnic Institute”

Abstract

This work analyses the results of the basic research relating to a new field of knowledge generally known as genetic foresight. We have reviewed theoretical basis and levels of knowledge representation for genetic foresight processes. We have also demonstrated the necessity for sharing intellectual and prognostic potential of two genetic systems: Human-Based and Generating Periodic System of Primary Elements. We further analysed the results and prospects for use of genetic foresight methods in science, education and innovative technology.

Keywords: generating system, genetic code, foresight, synthesis, electromechanical objects, genetic innovation banks.

INTRODUCTION

The problem of scientific foresight is one of the key research issues and one of the crucial functions of science. The significance of this issue was very vividly described by Wilhelm Ostwald, the eminent scientist and the Nobel Prize winner in Chemistry 1909: “The knowledge, which tells us nothing about the future, is dead, and cannot bear an Honourable Title of Science.”

Functioning and performance of man-made engineering systems are defined by their structure. Therefore, we must find the science-based foresight methods which would allow carrying out direct search (including guaranteed completeness of possible solutions) and synthesis of new structural types of the systems that meet the function requirements. Until recently, scientists believed that collection of such system information in engineering sciences, including electromechanics, is one of some most challenging tasks.

Genetic electromechanics, which studies integral, highly-ordered electromagnetic structures containing genetic information about the developing structural classes of electromechanical energy converters (EMEC), became one of the disciplines first to allow developing fundamentals of electromechanical systems (EM-Systems) genetic evolution theory based upon structural and system approach [1].

SOURCES OF GENETIC FORESIGHT

Genetic foresight is a new interdisciplinary field of scientific knowledge, which aims to discover and explore invariant properties of

Periodic Generating Systems and determine, on their elemental basis, classes of potentially possible descendant structures unknown at present but genetically predetermined by the properties of the source system elements [2].

Foresight based on the principles of genetic organisation of the developing systems has a dual nature (Fig. 1).

On the one hand, each of us is genetically able to predict or anticipate as we have an innate cognitive instinct [3]. As we know, a human instinct system, which also includes cognitive instinct, helps a human continue to exist in a changing environment. This most important function realises through the cognitive mechanisms of thinking, which quality and resources largely depend on the accumulated knowledge and complexity level of the obtained and processed information.

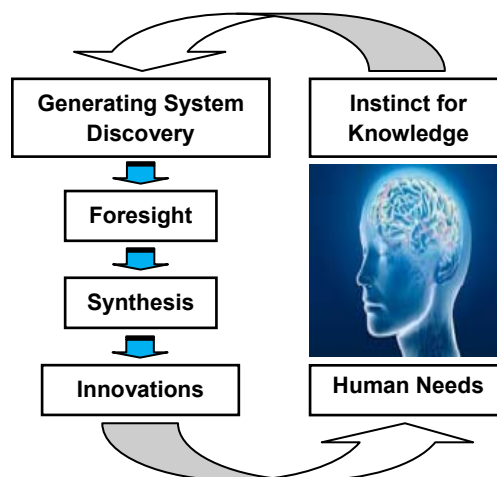


Fig. 1. Interrelationship of Genetically Defined Systems in Genetic Foresight Mechanisms

The more complex the information used in the process of thinking is, the more the brain needs for this process. Now that the amounts of information are increasing all the time, human need for systemic, well-ordered information which basically contains reduced (encoded) knowledge about a limited number of original elements and rules for their transformation. Therefore, genetic principles form both a human genotype and have a decisive influence on its behaviour through phenotypic (acquired during the evolution) properties (way of thinking, language, educational and cultural systems).

On the other hand, the original element basis, axiomatics and a variety of objects with certain physical nature were encoded by Mother Nature in the structure of the unique, highly ordered system formations – Generating Periodic Systems, which element basis has genetic information in addition to the specific properties typical for this class of systems (chemical, biological, electromagnetic, etc.).

A Man is the key generating figure in genetic foresight mechanisms as it has the

required level of specific and interdisciplinary knowledge. The main idea of genetic foresight method is sharing the heuristic potential of the two genetically organised systems (Man with its developing cognitive instinct, and the Generating System with its genetic programmes and prognostic function).

GENERATING SYSTEM

From the standpoint of the structural and system approach, EMEC belong to a unique class of systems of natural and natural/ anthropogenic origin which have their own genetic structure and directed human activities – evolution of Species [1]. According to the genetic theory of EM-Systems structure formation, the function of generating electromagnetic structures is performed by primary sources of electromagnetic field (parent electromagnetic chromosomes) which variety is ordered by their Generating Periodic System – Genetic Classification (GC) of electromagnetic field primary sources (Table 1).

Table 1

Electromagnetic Elements Periodic Generating System
(First Long Period)

		Г Р У П П Ы								
		0.0	0.1	0.2	1.0	1.1	1.2	2.0	2.1	2.2
П Е Р И О Д Ы	ЦЛ	ЦЛ 0.0x			ЦЛ 1.0x	ЦЛ 1.1x		ЦЛ 2.0x	ЦЛ 2.1x	ЦЛ 2.2x
		ЦЛ 0.0y	ЦЛ 0.1y	ЦЛ 0.2y		ЦЛ 1.1y	ЦЛ 1.2y			ЦЛ 2.2y
	КН	КН 0.0x			КН 1.0x	КН 1.1x		КН 2.0x	КН 2.1x	КН 2.2x
		КН 0.0y	КН 0.1y	КН 0.2y		КН 1.1y	КН 1.2y			КН 2.2y
	ПЛ	ПЛ 0.0x			ПЛ 1.0x	ПЛ 1.1x		ПЛ 2.0x	ПЛ 2.1x	ПЛ 2.2x
		ПЛ 0.0y	ПЛ 0.1y	ПЛ 0.2y		ПЛ 1.1y	ПЛ 1.2y			ПЛ 2.2y
	ТП	ТП 0.0x			ТП 1.0x	ТП 1.1x		ТП 2.0x	ТП 2.1x	ТП 2.2x
		ТП 0.0y	ТП 0.1y	ТП 0.2y		ТП 1.1y	ТП 1.2y			ТП 2.2y
	СФ	СФ 0.0x			СФ 1.0x	СФ 1.1x		СФ 2.0x	СФ 2.1x	СФ 2.2x
		СФ 0.0y	СФ 0.1y	СФ 0.2y		СФ 1.1y	СФ 1.2y			СФ 2.2y
	ТЦ	ТЦ 0.0x			ТЦ 1.0x	ТЦ 1.1x		ТЦ 2.0x	ТЦ 2.1x	ТЦ 2.2x
		ТЦ 0.0y	ТЦ 0.1y	ТЦ 0.2y		ТЦ 1.1y	ТЦ 1.2y			ТЦ 2.2y

Note: The symbols on the dark background are the genetic codes of the Species involved in the EM-Systems technical evolution.

The order of the primary elements in the GC structure directly depends upon the fundamental conservation principles: electromagnetic symmetry conservation principle (within the groups), topological invariance principle (within the subgroups) and P. Curie's dissymmetrisation principle (within the short periods). The presence of these systemic correlations determines the regularity of the GC elements' properties defined by the integral periodic law.

The deterministic relationship between the GC element basis and the descendant objects at any level of their development (structural evolution) is supported by the fundamental principle of genetic information conservation. Therefore, the Periodic Generating System is a form of presentation of principles of conservation of the object with a certain type of physical nature and at the same time play the role of a genetic programme of descendant object structure formation.

KNOWLEDGE REPRESENTATION LEVELS

The genetic "simple – to complex" principle implemented by Nature through the fundamental principle of genetic information conservation determines the level hierarchy for structural organisation of the developing genetic systems. Each level is associated with a particular axiomatic and element basis, a certain kind of genetic models of structural development and a specific class of foresight tasks.

Element Level. Periodic GC structure plays a role of a system model of EMEC structural diversity. The element basis at the GC level is represented by an ordered variety of primary sources of electromagnetic fields (sets of parent electromagnetic chromosomes).

Formulation of foresight tasks on the element basis of the Periodic Generating System inevitably leads to the discovery of specific conservation principles and system-wide laws of the structural organisation of the studied class of systems. With regard to the GC structure, the result of such studies was the discovery of the electromagnetic symmetry conservation principle, topological invariance principle and integral periodic law, which reflect the most general properties of the primary electromagnetic structures.

It was at the genetic level that scientists first predicted and then experimentally proved the fundamental properties of the primary electromagnetic structures such as the genetic coding principle, isotopy properties, pairing principle, primary and secondary periodicity, and homology. At this stage, the research results generalisation finished with laying the foundations for the theory of EM-Systems genetic evolution [1].

Genome Level. Classes of foresight tasks which refer to the genome level of the electromagnetic object structural organisation belong to a brand new research trend in genetic electromechanics generalised by genome studies issue [4]. Genomics is aimed to the synthesise and then carry out the genetic analysis of sets of paired electromagnetic chromosomes which determine structural diversity of EMEC functional types and classes. The number of the generating structures in a genome of each EMEC Specie is strictly limited which guarantees search completeness and proper orientation of synthesis procedures of such structural compositions. Genome research methodology consists of genetic code identification methods and methods of decoding of genetically modified chromosome sets which determine electromagnetic systems population structure and functional classes.

Preliminary analysis of genome decoding carried out for electrical machines of various structural and functional classes shows that over 180 years of evolution of inductive electrical machines, up to 5% of the baseline level Species from among those potentially possible have become widely used. A large number of species (25% – 30%) have an information status and their structural representatives are presented as descriptions, drawings, patents and other types of research and technical documentation. The vast majority of EM-Systems are implicit (not available at this point of evolution) but genetically determined by the composition of their genetic information in the genome structure of EMEC classes. The relative number of such species varies from 60% to 70% (for evolutionarily mature EMEC classes) and up to 80% – 95% (for the classes at their early stage of evolution).

The author associates the ultimate goal of the genome research programme with formation

of genetic innovation banks and knowledge bases – the unique information systems that integrate the results of genome studies [4]. Such systems are designed for storage, analysis and practical application of system genetic information about the hidden structural potential of the implicit (not yet enabled at this stage of the structural evolution) EMEC species and varieties.

Object Level. Genetic foresight task formulation and solving at the level of undefined electromagnetic or electromechanical objects (coils, transformers, inductors, and electrical machines) are based upon the EM-Systems homologous series law [2]. Occurrence of real homologous series in the process of the structural EMEC evolution can be explained by logical reflection of the primary elements' group properties in the GC periodic structure. The above properties are subject to the field source topological invariance principle. Such patterns allow uniquely identifying all objects of the homologous series by the structure and properties of a single representative of the unknown series.

A group of homeomorphic (topologically equivalent) transformations taking place within a determined topological space is the formalised basis of the electromechanical objects (EM-objects) homologous series direct synthesis. The results of the search problem-solving are represented as the sets of topologically equivalent structures with different spatial geometry generalised by the concept of an “ideal homologous series” which brings together all representatives of the real information and implicit (i.e. still absent at this point of evolution) homologous EMEC Species.

The results of the homologous series synthesis are highly intelligent data which serve as a basis for the formation of genetic innovation banks and development of innovative projects.

Population Level and Species Level. The tasks of genetic foresight and directed synthesis of new EMEC structural types for a prescribed function refer to the population and species levels of knowledge representation.

Axiomatics of these EMEC structural foresight levels, which play an important methodological role, is determined by the fundamental principles of genotypic variability: in-

traspecific crossing, inversion, replication, crossing-over and mutation which combinatorial space ensures a wide genotypic diversity of EM-objects.

The model basis of these levels is represented by the appropriate genetic speciation models (Fig. 2) which reflect the structural diversity and limits of genetic variability of random EMEC Species populations.

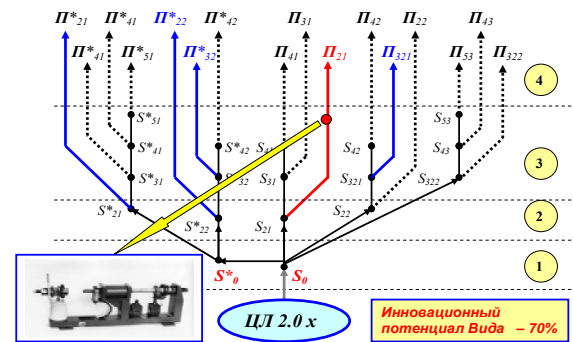


Fig. 2. Genetic Model of Structural Foresight at Intraspecific Level (Species of Cylindrical Translational Motion Asynchronous Machines Ц/Т 2.0x)

New EMEC type's foresight and discovery task formulation and solving are based upon the genetic models of macroevolution of the studied functional classes (Fig. 3). These models represent the interrelationship of the GC element basis with species variety of both existing (evolution spiral events) and still absent Species within the investigated functional EMEC class.

Genetic principles of complex systems structural organisation are system-wide and form the basis for the synthesis of both living organisms and man-made technical systems [5, 6].

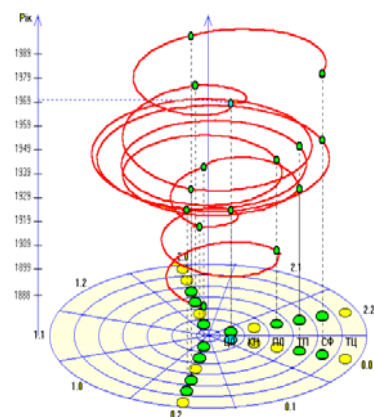


Fig. 3. Genetic Macroevolution and Foresight Model for Species Diversity of Asynchronous Electrical Machines

Taxonomic Level. The task of building taxonomy of the objects of different physical nature is a general scientific problem and an independent fundamental research branch. The subject of the taxonomic study is the increasing diversity of the communities of genetically related species of different ranks.

Presence of the periodic system of genetic codes and the development of genetic speciation theory allowed discovering a genetic approach to EMEC taxonomy [7]. The distinctive feature of EMEC genomic taxonomy is that its taxonomic structure is determined by the GC periodic structure and universal structure of genetic codes. In this case, the systematic units of any rank will perform a prognostic function because their taxons will contain information about the structure of the classes still absent at this stage of technological evolution.

By the present stage, researchers have designed the methodological framework for genomic taxonomy, determined the level of structural evolution, rank structure of taxons and quantity of real and implicit forms of all major functional classes of electrical machines, including the following types: rotational and translational motion, combined and hybrid electromagnetic systems, separate production EMEC classes [6, 7].

System Level. The foresight tasks for a more complex level classes (functional, hybrid, combined systems that integrate EMEC structure and other genetic nature systems and other components (mechanical, hydraulic, electronic, biological, etc.)) refer to the system level of knowledge representation.

Axiomatic basis for the system level is represented by phylogenetic macroevolution models as well as the models of intrageneric and intergeneric crossing. Once the innovative tasks for the system level structural complexity were formulated and solved, the researchers were able to identify the principles and boundaries of the existence of hybrid and combined EMEC and to synthesise the new classes [6].

The structural foresight methodology has been successfully tested in numerous innovative designing tasks. As an example, Fig. 4 shows a phylogenetic tree of multiple-factor

electromechanical disintegrators (EMD) managed evolution.

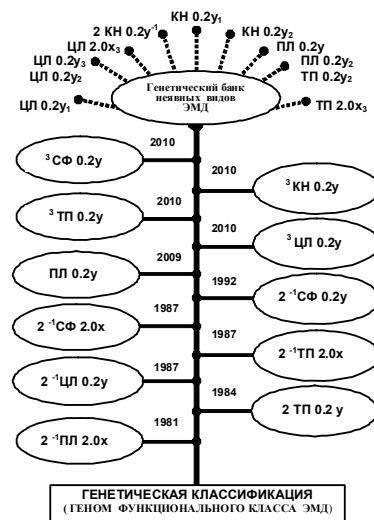


Fig. 4. Practical Implementation of the Structural Foresight Results by Example of the New Class of Multiple-Factor Electromechanical Disintegrators (Genetic codes of the new EMD types and patenting dates)

The EMDs belong to a new class of high-performance electromechanical transducers invented and created by using structural foresight techniques. The EMDs made by a group of authors found application in the methods of direct implementation and intensification of various production processes: nano-sized materials production, homogeneous mixing, of multi-component fuel mixtures preparation, synthesis of composite materials, chemical reactions acceleration, biotechnologies, etc. For the first time in history, it became possible to direct the structural evolution of this class of devices by using the genetic innovation bank.

The discovery of electromagnetic spatial and structural isomerism was the next step in system GC properties learning. It was first genetically predicted and subsequently found at various levels of structural organisation of EMEC functional classes [8].

Interdisciplinary Level. We can use the Generating Systems multiplicity hypothesis to differentiate the upper level in the knowledge representation hierarchy and denote it as an interdisciplinary level. The model basis of this level is represented by a conceptual model of an X-type Generating System [2] which is a form of system-wide principles reflection

(self-similarity principle, symmetry preservation principle, topological invariance principle and integral periodic law) that are invariant to the physical nature of the Generating System's elements. The author based upon such model to investigate the multidimensional periodicity and to determine the principle of genetic coding in the periodic system of natural numbers, which acts as the Generating System in mathematics.

The issue of *X*-type generating systems foresight and discovery is a brand new, yet unexplored area of the interdisciplinary level of knowledge. Its analysis is beyond the scope of this article and is the subject of an independent scientific research and philosophical generalisation. The discovery of new Generating System analogues in the future means that the theory of genetic evolution of complex developing systems of natural and natural/anthropogenic origin can become the synthesising theory of scientific foresight.

CONCLUSION

The results of the analysis of structures and invariant properties of the periodic type Generating Systems discovered previously (chemistry, biology (fragments)) and studied recently by the author (electromagnetism, theory of numbers) allow stating that the genetic foresight methods should be considered as a new area of interdisciplinary knowledge implemented by Nature via genetically organised systems.

The comparative analysis of the information contained in the genomes of functional classes and Species with the results of EMEC structural evolution clearly indicates that a Man is not the only creator of the technological advance, as previously considered, but it is only a Nature's apprentice. All inventions made by many generations of professionals were long

ago foreseen by Nature in its genetic programmes. Genetic foresight opens up the possibilities to rise up to a new level of system knowledge which determine the strategies for innovative development of the engineering systems under severe time and energy resource restrictions.

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