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GENETIC-MORPHOLOGICAL SYNTHESIS OF MACHINE – TOOL RACKING

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Keywords: material point, genetic formula, morphological model, cutting tool, clamping principle.

Abstract. A fundamentally new methodological approach to the creation of progressive machine-tool equipment is proposed when considering a material point as a carrier of genetic information in the synthesis of technical systems of the "object" type. The main attention is paid to the search for new technical solutions with the use of tangential clamping, which allows one movement to simultaneously clamp several cutting tools offset from the axis of rotation, for example, in the form of carbide non-regrowth inserts.

ГЕНЕТИКО-МОРФОЛОГИЧЕСКИЙ СИНТЕЗ СТАНОЧНО- ИНСТРУМЕНТАЛЬНОЙ ОСНАСТКИ

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Ключевые слова: материальная точка, генетическая формула, морфологическая модель, режущий инструмент, принцип зажима.

Аннотация. Предложен принципиально новый методологический подход к созданию прогрессивной станочно-инструментальной оснастки при рассмотрении материальной точки как носителя генетической информации при синтезе технических систем типа «объект». Основное внимание уделено поиску новых технических решений с использованием тангенциального зажима, позволяющего одним движением одновременно зажимать несколько смещенных от оси вращения режущих инструментов, например, в виде твердосплавных неперетачиваемых пластин.

Introduction. Creation of new developing technical systems (TS) require further improvement of their subsystems. At present, the search for new solutions is not possible without an interdisciplinary approach and the use of the latest scientific advances in various fields, combined in the form of NBICSE (nano-bio-info-cogno-socio-eco) – technologies and using artificial intelligence [1,3,7,8,12,16,17]. The challenges of “INDUSTRY 4.0” [6,11] are mainly focused on artificial intelligence, full automation using robots, robotic systems, communications, the creation of intelligent production of a new generation while achieving the following main goals: 1. Increased productivity. 2. Improving product quality. 3. Reducing the cost of environmentally friendly production while saving energy and material resources. 4. Improvement and decrease in the proportion of physical labor. 5. Facilitation and reduction of monotonous intellectual work. 6. Expansion of technological and functional capabilities of equipment. This determined the global trends in the development of mechanical engineering [9,22].

Research goal. Studying and analyzing the stages of the evolutionary development of technical systems (TS) and the principles of creative thinking, substantiate the effectiveness of the new ideology of designing machine-tool equipment, providing for the use of a genetic-morphological approach with the basic genetic principle “from simple to complex” [2,12].

The essence of the proposed scientific approach. The idea is that the main creator is Nature with all objective laws and phenomena, partially discovered by

Man, who is an unsurpassed creation of Nature and a creator in his own likeness [12, 14]. This determined the paradigm (postulate) of a new scientific approach - from living Nature to the creation of anthropogenic systems [2,4,15]. , which include static and dynamic machine, electrical, construction vehicles, thanks to the intellect of Man, which is declared in the philosophical ideas and prophecy of Acad. V.I. Vernadsky: "With the appearance on our planet of a living creature gifted with intelligence, the planet passes into a new stage in its history. The biosphere passes into the noosphere (the sphere of reason) ... We are just beginning to create an irresistible power of scientific thought, the greatest creative power of Homo Sapiens, a human free personality, the greatest known manifestation of its cosmic power, the kingdom of which is ahead "[5].

The creation of new developing TS is impossible without analyzing and taking into account the accumulated human experience, which, like genetic information on various carriers, is transferred from generation to generation. The history of the development of human society and the evolution of technology have always been associated with mechanics [9]. The main feature of recent decades is the comprehension of the development of modern super technologies for solving not only technical, but also social, environmental, spiritual, psychological and cultural problems, research on which is of an interdisciplinary nature [24]. Genetics and cybernetics, previously subjected to devastating criticism, paved the way for knowledge and their interdisciplinary use in the creation of new techniques and new technologies [3, 15, 21].

By analogy with the proposed prof. Shinkarenko V.F. a periodic system of electromagnetic elements (primary sources of the electromagnetic field), called the electromagnetic gene, and thanks to the principles of self-organization and the genetic principle "from simple to complex" [19-21]. a new view of the material point as a carrier of genetic information when creating a TS of the "object" and "process" type is proposed [10, 18]. This material point at the genetic level is conventionally called a mechanical gene and carries information about translational and rotational movements, loads and their directions (Fig. 1). The transfer of information from point O1 to point O2 with different coordinate systems is shown in Fig. 2, and without taking into account the directional vector, it is described by a morphological model (matrix and Table 1) with 18 options for implementing the clamping principles (axial, radial, tangential).

Morphological matrix of clamping principles without specified direction

$$\begin{pmatrix} Fa_1 & Fa_2 \\ Fr_1 & Fr_2 \\ Ft_1 & Ft_2 \\ Ma_1 & \blacksquare \\ Mr_1 & \blacksquare \\ Mt_1 & \blacksquare \end{pmatrix} N_{n3}=6 \times 3=18.$$

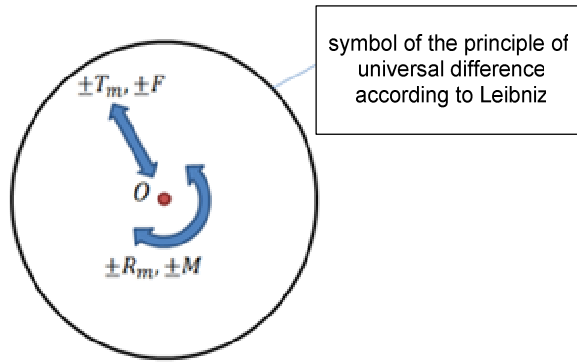


Fig. 1. Material point (T.O) is a mechanical gene that carries information about the type of displacements and loads of translational ($\pm T_m$; $\pm F$) and rotational ($\pm R_m$; $\pm M$) with direction indication

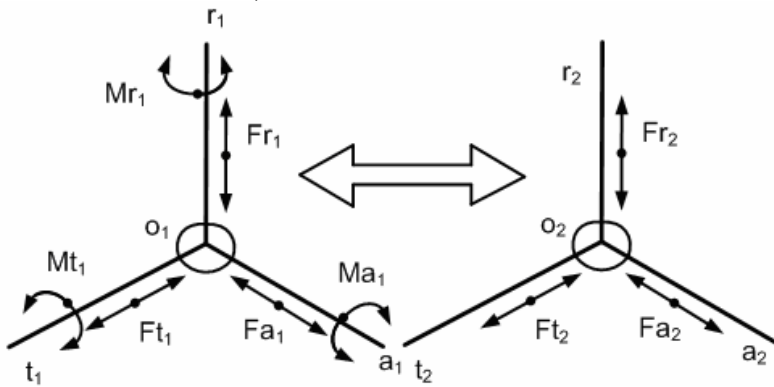


Fig. 2. Information transfer from point O_1 to point O_2

Tab. 1. Collapsed generating system of clamping principles without specifying the direction (force vector - load)

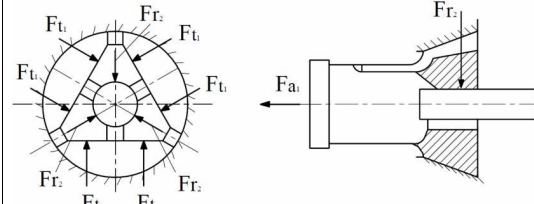
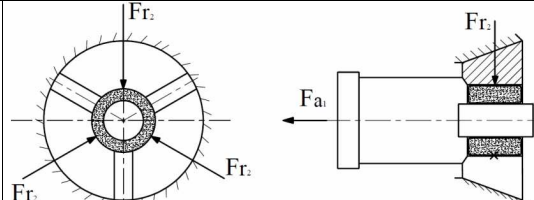
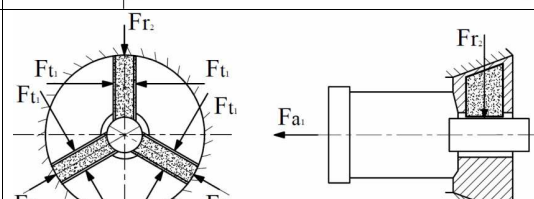
Input \ Exit		F_2		
		F_{a2}	F_{r2}	F_{t2}
F_1	F_{a1}	$F_{a1} - F_{a2}$	$F_{a1} - F_{r2}$	$F_{a1} - F_{t2}$
	F_{r1}	$F_{r1} - F_{a2}$	$F_{r1} - F_{r2}$	$F_{r1} - F_{t2}$
	F_{t1}	$F_{t1} - F_{a2}$	$F_{t1} - F_{r2}$	$F_{t1} - F_{t2}$
M_1	M_{a1}	$M_{a1} - F_{a2}$	$M_{a1} - F_{r2}$	$M_{a1} - F_{t2}$
	M_{r1}	$M_{r1} - F_{a2}$	$M_{r1} - F_{r2}$	$M_{r1} - F_{t2}$
	M_{t1}	$M_{t1} - F_{a2}$	$M_{t1} - F_{r2}$	$M_{t1} - F_{t2}$
Clamping principle		Axial	Radial	Tangential

A material point can be fixed, as information about static vehicles of the “object” type (tools, structures, supporting systems of technological equipment), and movable, as information about dynamic vehicles of the “process” type [2, 10]. Thanks to the fruitful cooperation of mechanics and electromechanics using approaches in genetic electromechanics and universal genetic operators of synthesis (replication, inversion, crossing, crossing over, mutation) [13, 22], fundamentally new mechanisms and nodes have been created.

The effectiveness of the proposed approach is clearly illustrated by the example of pull-type collet chucks (CP) with wedge WD and spring SR converters (Table 2), where the force is F_{a1} and F_{t1} at the input, and F_{r2} and F_{t2} at the output. Topology demonstrates the fruitful influence of the contradictions between intuition and logic [12, 16]. Table 2 (pos. 8 and 9) shows examples of the implementation of ideas for creating wide-range collet ZPs with a liquid flowing medium LMF (liquid flowing medium). The same ideas can be implemented for a wide range in shape and size when using bulk media BLM (bulk medium).

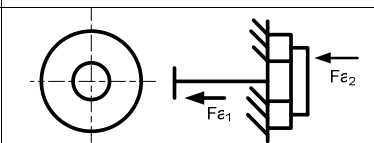
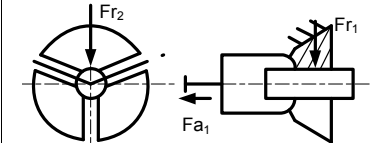
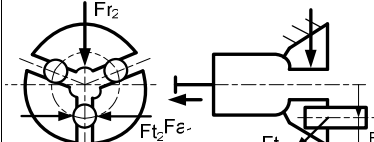
Tab. 2. Schemes of known and new collet chucks with genetic formulas at the population level

№ p/p	Scheme chuck	Genetic formula	Chuck type
1		$F_{a1} - WD - 3F_{r2}$	Standard
2		$F_{a1} - WD - 3F_{r2}$	High-speed instrumental
3		$F_{a1} - (WD \cdot SR) - F_{r2}$ $WD \cdot SR \rightarrow \text{hybrid GB}$	High-speed tool with spring collet
4		$F_{a1} - WD - 3F_{r2}^1 -$ $- SR - 3F_{r2}^2$ or $F_{a1} - (WD \cdot SR) - 3F_{r2}$	High precision with flanged collet
5		$F_{a1}^2 - SR \neg$ $F_{a1}^1 - WD^1 - \otimes -$ $- WD^2 - 3F_{r2}$	Self-adjusting

6		$F_{a_1} - WD^1 - 3F_{t_1} - WD^2 - 3F_{r_2}$	Wide-range single multiplication
7		$F_{a_1} - WD - 3F_{r_2} \cdot (LMF)$	Wide-range fluidized
8		$F_{a_1} - WD - 3F_{t_1} \cdot (LMF) - F_{r_2}$	Wide-range with tangential clamping and liquid-fluid medium

Below is the implementation of the new approach, formulated by a morphological model in the form of a matrix of clamping principles and as an opening of a folded generating system (Table 1), which is clearly depicted with genetic formulas at the population level (Tables 3 and 4).

Tab. 3. Examples of the implementation of the principles of clamping in the power flow with the genetic code F_1-F_2

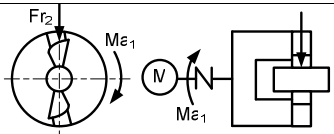
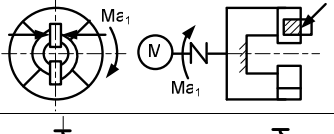
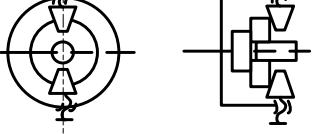
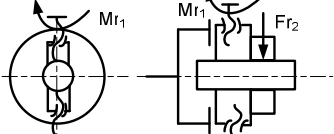
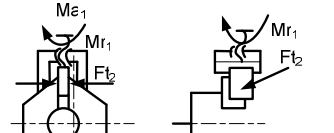
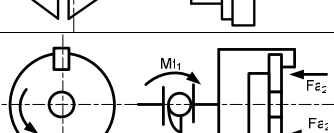
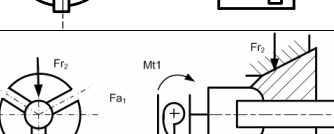
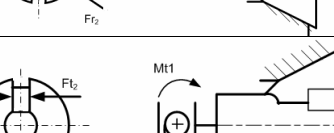
No p/p	Chromosome	Genetic formula at the population level	Principled schema
1	$F_{a_1}-F_{a_2}$	$F_{a_1}-PL-F_{a_2}$	
2	$\underline{F}_{a_1}-F_{r_2}$	$\underline{F}_{a_1}-WD-F_{r_2}$	
3	$F_{a_1}-F_{t_2}$	$F_{a_1}-WD-F_{t_2}$	

4	Fr_1-Fa_2	$Fr_1-WD-Fa_2$	
5	Fr_1-Fr_2	$Fr_1-SR(TRF)-Fr_2$	
6	Fr_1-Ft_2	$Fr_1-WD-Ft_2$	
7	Ft_1-Fa_2	$Ft_1-WD-Fa_2$	
8	Ft_1-Fr_2	$Ft_1-WD-Fr_2$	
9	Ft_1-Ft_2	$Ft_1-WD-Ft_2$	

Conclusions. It becomes obvious that Man is not the sole creator of technical progress, as previously thought, but remains only a student of Nature. Everything that has been invented by many generations of specialists has long been foreseen by Nature in its genetic programs. Nature establishes the laws of structural organization, creates genetic programs for the development of complex systems and dictates strict rules for their construction.

Tab. 4. Examples of the implementation of the principles of clamping in the power flow with the genetic code M_1-F_2

N_0 p/p	Chromosome	Genetic formula at the population level	Principled schema
1	Ma_1-Fa_2	$Ma_1-SC(EMF)-Fa_2$	

2	Ma_1-Fr_2	$Ma_1-SP(EMF)-Fr_2$	
3	Ma_1-Ft_2	$Ma_1-SP(EMF)-Ft_2$	
4	Mr_1-Fa_2	$Mr_1-SC-WD-Fa_2$	
5	Mr_1-Fr_2	$Mr_1-SC-Fr_2$	
6	Mr_1-Ft_2	$Mr_1-SC-WD-Ft_2$	
7	Mt_1-Fa_2	$Mt_1-SP-PL-Fa_2$	
8	Mt_1-Fr_2	$Mt_1-SP-WD-Fr_2$	
9	Mt_1-Ft_2	$Mt_1-SP-WD-Ft_2$	

The era of transition from virtual to real is coming, since the basis of the progress of material production ("more-better-cheaper") was and remains production technologies and technical means (material and energy flows), and not computers intended for virtual work and related to information streams. They are always only auxiliary and secondary in the TS, but the main ones in intelligent systems. The proposed interdisciplinary approach will allow for an innovative breakthrough and the search for many unexpected non-standard solutions for the creation of new equipment and the latest technologies in a short time in the face of the challenges of Industry 4.0.

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