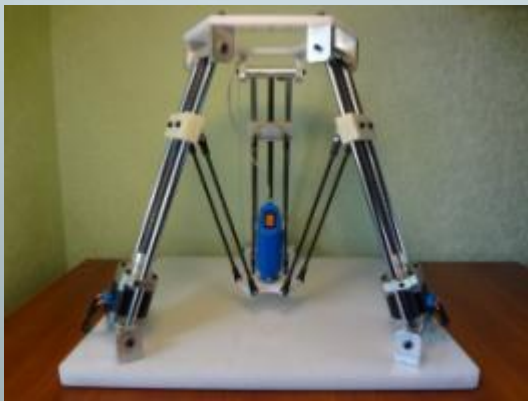


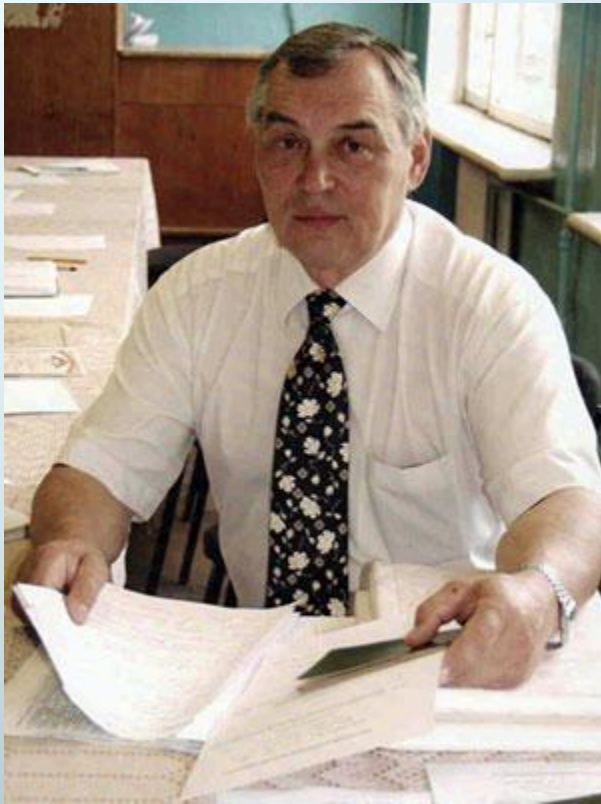
**MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE  
NTUU "KIEV POLYTECHNIC INSTITUTE"  
DEPARTMENT OF MACHINE TOOLS AND MACHINE DESIGN**



**The achievements of the scientific school of  
Professor Yuri Kuznetsov  
in the machine tool industry**

**E-mail: [info@zmok.kiev.ua](mailto:info@zmok.kiev.ua)**





## **Yuri Kuznetsov**

**DSc, Professor "KPI"**

**He was born June 24, 1940 in Kherson, Ukraine. His research interests include the creation of machine tools, machine tool systems of new generation and their mechanisms on a modular principle, creative and intellectual property.**

**In 1969 he defended his thesis on "Study and development of the clamping collets and feed rounds of automatic lathes", and in 1984 at the Bauman Moscow Higher Technical School defended his doctoral thesis on "Synthesis of clamping mechanisms rod machines".**

**Academician of the Academy of Sciences of Higher School of Ukraine, professor of "Designing tools and machines" "KPI ", honored inventor of the USSR, the deserved worker of Education of Ukraine, Honored Teacher "KPI ", Doctor Honoris Causa (Technical University of Gabrovo, Bulgaria), the author of more than 700 scientific works, among them 60 books, 400 inventions, two standards of the USSR. The author of the first Soviet semi-automatic machine for turning diamonds.**

# Disciples and followers

## Senior generation:

Doctors of Technical Sciences, Professors: V.I. Kalchenko, A.A. Vacev (Bulgaria), S.G. Nagornyak, Yu. M. Danilchenko, A.V. Shevchenko, I.V. Lutsiv, V.I. Sidorko.

Ph.D., docents: K.I. Proskuryakov, V.A. Krijanovskiy, V.V.

Torba, S.P. Syarov, V.I. Dementev, V.G. Kojevnikov, V.N.

Ahramovich, A.S. Romashko, V.N. Voloshin, Yu.P. Dyachenko,

N.A. Ivaniuk, V.G. Kushik, A.V. Litvin, Yu.A. Sud'in (Russia),

S.V. Miroshnichenko (Russia) V.I. Barsuk (Russia), N.

Duskarayev (Uzbekistan), Nguen ba Fuk (Vietnam).

# Disciples and followers

## Middle generation:

Ph.D., docents: R.G. Redko, R.A. Skliarov, I.L. Kushil, A.V.

Samoilenko, V.B. Firansky, D.A. Dmitriev, V.V. Guminov, P.M.,  
Nedelcheva (Bulgaria), El-Rashini Husein Ali (Lebanon),

El Dakhabi Faruk Vakhid (Lebanon), Ramadan Valid (Jordan),

Khasan Al-Dabas (Jordan), El-Refo Ibragim Farhad (Jordan).

# Disciples and followers

## Young generation:

Ph.D., docents: O. Ya. Yurchishin, B. I. Pridalniy.

Aspirants: K.V. Luniov, A.A. Stepanenko, P.V. Keba, O.I. Rozhko, E.A. Oleynik, A.A. Shkurenko.

Applicants: M.I. Podolskiy, V.A. Nedoboi.

Masters: A. Shevtsov, I. Shipko, K. Litovka, S. Savitsky.



# Books about machine tools and mechanisms



**Aggregate-module technology equipment Part 1**



**Aggregate-module technology equipment Part 2**



**Aggregate-module technology equipment Part 3**



**Tooling for lathes**



**Processing of polygonal surfaces**



**Improving the efficiency of automatic lathes**



**Theory of technical systems**



**Cutting rods and tubes**

# Books about parallel kinematic machines

Technological equipment with parallel kinematics



Types of machine tools with the mechanisms of parallel structure



# Books about the clamping mechanisms



Wide-range multi-purpose clamping mechanisms



The clamping mechanisms for high-performance and high precision machining



Self-adjusting clamping mechanisms

# Books about patenting



**Patenting and  
copyright**



**Practice on the subject  
«Patenting and  
copyright»**



# **Main research areas**

- 1. Creation (synthesis), design, calculation and study of the clamping mechanisms and devices for various purposes, and clamping devices, and automatic manipulation of objects (workpieces, tools, working tools)**
- 2. Creation of semi-automatic machine tools for the turning of crystals of natural diamond and their holding systems.**
- 3. The creation and study of cutting devices, and carrier systems for cutting steel**

# Main research areas

- 4. The creation, design, computation and research tools and other technological equipment of new generation, including with parallel kinematics.**
- 5. The creation of desktop machine tools, controlled by the computer on a modular principle for educational process.**
- 6. Creating a clamping mechanisms, and tooling for high speed and a precision machining on lathes and milling machines.**
- 7. A genetic approach to the creation of complex technical systems**

*recent advances...*

**"GENETIC PROGRAMS  
OF COMPLEX, EVOLUTIONARY SYSTEMS"**

# BACKGROUND FOR THE DEVELOPMENT OF GENETIC MECHANICS

- **Mechanics is an ancient science and the first step to facilitate the physical labor of man - has always been associated with the design based on geometric constructions.**
- **Creating new or recreating a kind known, the man has always turned to geometric constructions (geometry, plane geometry and solid geometry).**
- **These simple ideas from ancient times used by the man in the intellectual, practical, industrial and other activities in the form of genetic information, recorded in various forms (signs, pictures, books, figurines, numbers, etc.) transferred from one generation to the evolutionary their development and synthesis of new TS.**
- **Stone Age people tools represent simple forms of bodies, on which all subsequent inventions have appeared in mechanics.**
- **The basis of the mechanical gene as a material carrier of hereditary information, created by nature, was put an **material point and elementary solid body** as a cylinder, parallelepiped, sphere, etc.**

# EXAMPLES OF ELEMENTARY SOLID BODIES AND FIGURES



Sphere



Circle



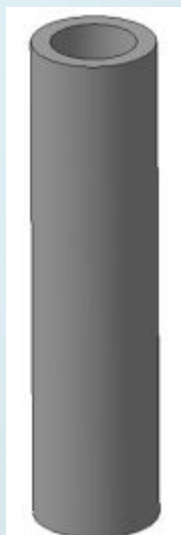
Cylinder



Disk



Circle



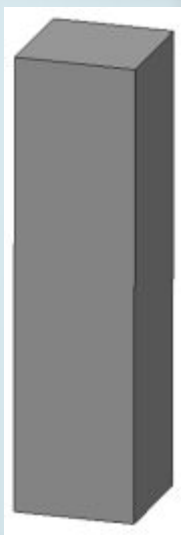
Pipe



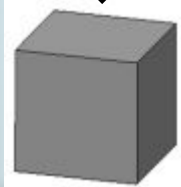
Ring



Concentric circles



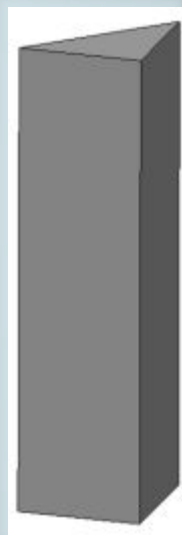
Parallelepipeds



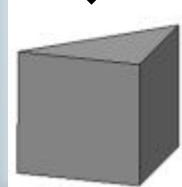
Cube



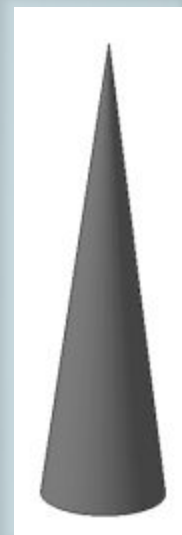
Square



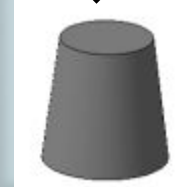
wedge



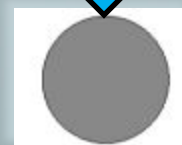
Triangle



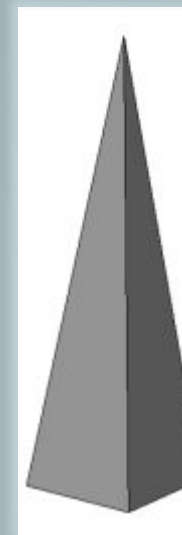
Cone



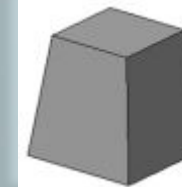
Truncated cone



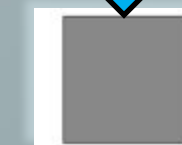
Circle



Pyramid



Truncated pyramid



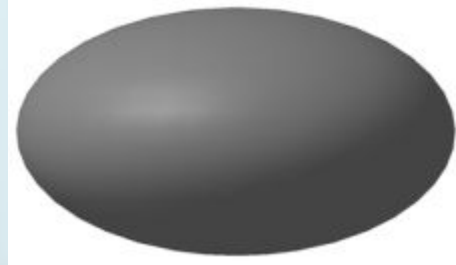
Square



# EXAMPLES OF DEFORMED (MODIFIED) ELEMENTARY SOLID BODIES



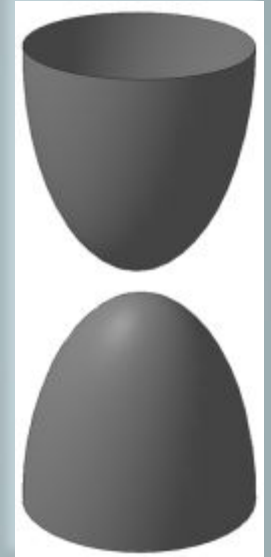
**Sphere**



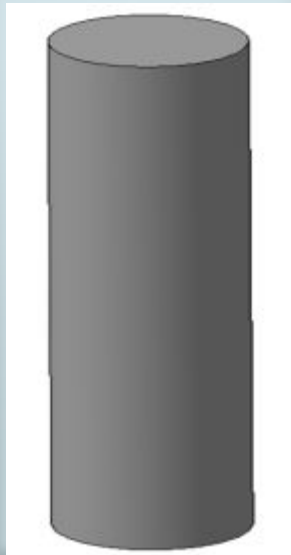
**Oblate ellipsoid**



**Oblong ellipsoid**



**Parted  
hyperboloid**



**Cylinder**



**Unparted  
hyperboloid**



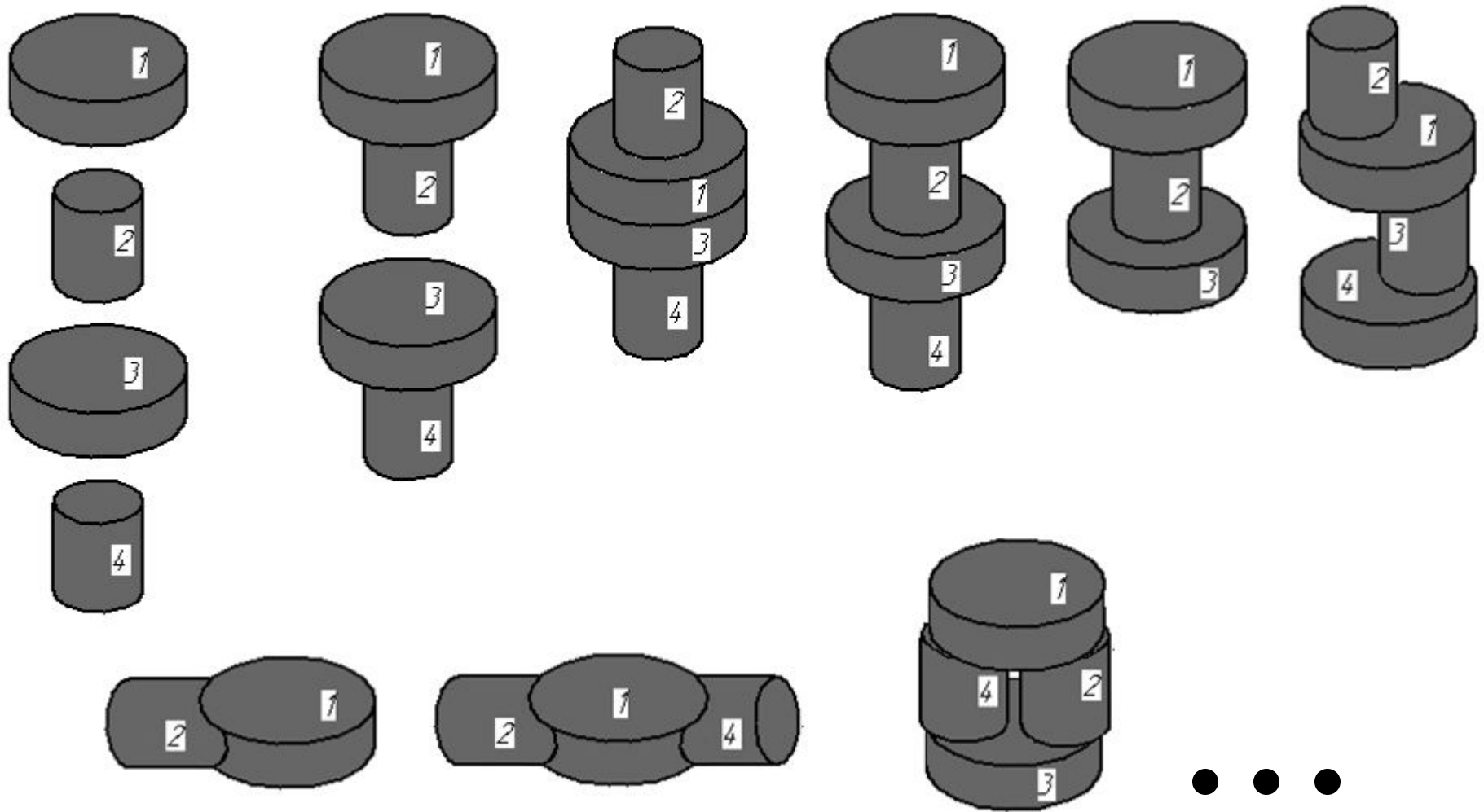
**Torus**



**Spiral**

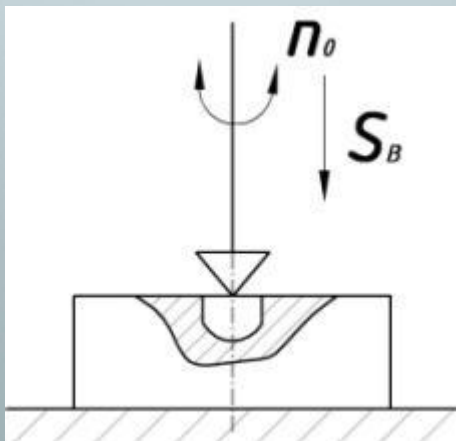
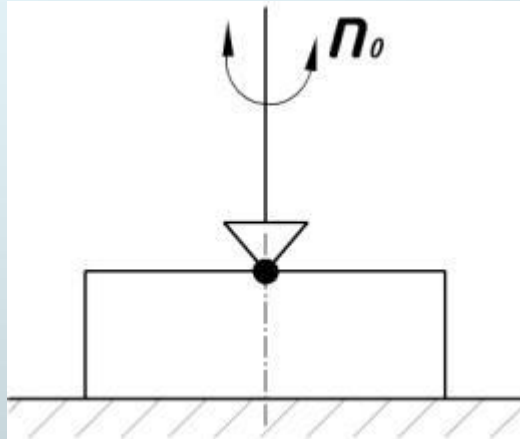
# EXAMPLES OF MECHANICAL LINKS

*Mechanical link is one or several rigidly mounted elementary solid bodies*

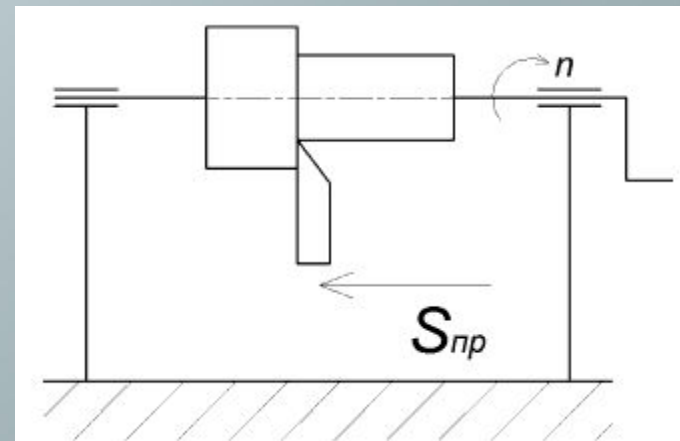
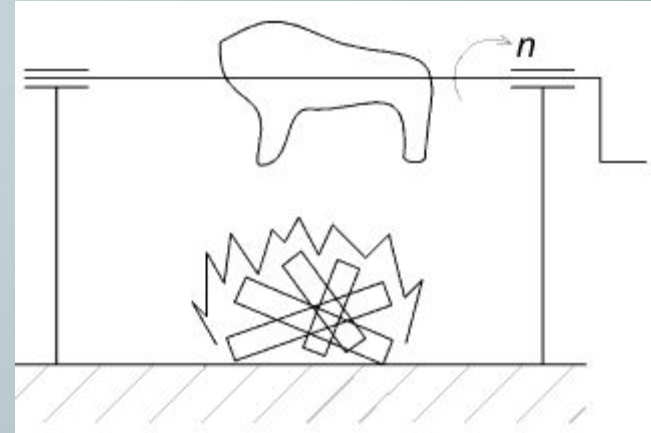


# EVOLUTION OF PARENT CHROMOSOME (MECHANICAL LINK IN THE FORM OF A CYLINDRICAL BODY) (Stone Age)

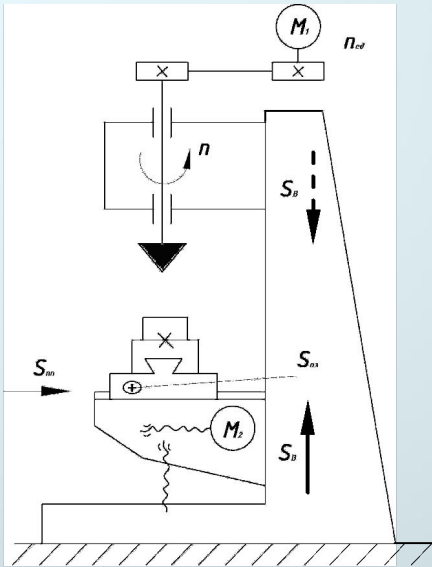
## VERTICAL DRILLING-MILLING MACHINE



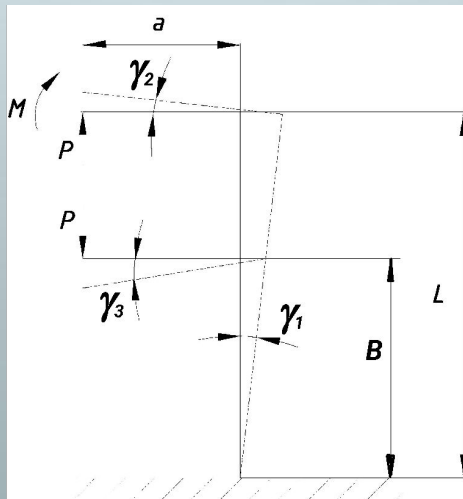
## LATHE MACHINES



# EVOLUTION OF VERTICAL DRILLING AND MILLING (end of XVII c. – XX c.)



Drilling and milling with a separate drive spindle speed  $N$  of motor and driven individual innings  $S_x, S_{y'}, S_{z'}$  by three coordinates  $X, Y, Z$  or from separate drive from CNC machine.



Console T-shaped rod of length  $L$  with a spindle bearing system  $a$  at the overhang and console coordinate table at an altitude of  $b$

Scheme is asymmetrical.

Asymmetrical arrangement causes the bending strain and distortions (angles  $\gamma_1, \gamma_2, \gamma_3$ )

# THE CONCEPT OF CREATING NEW GENERATION MACHINES

**Genetic principle, including :**

- Genetic approach to classification, description of the evolution development and forecasting of TS; multilevel morphological approach to structure and synthesys of TS.**
- Application of frame and shell structures of supporting systems based on the theory of building mechanics.**
- Aggregate/modular principle of arrangement.**
- Use of advanced information technologies and intelligent computer systems.**



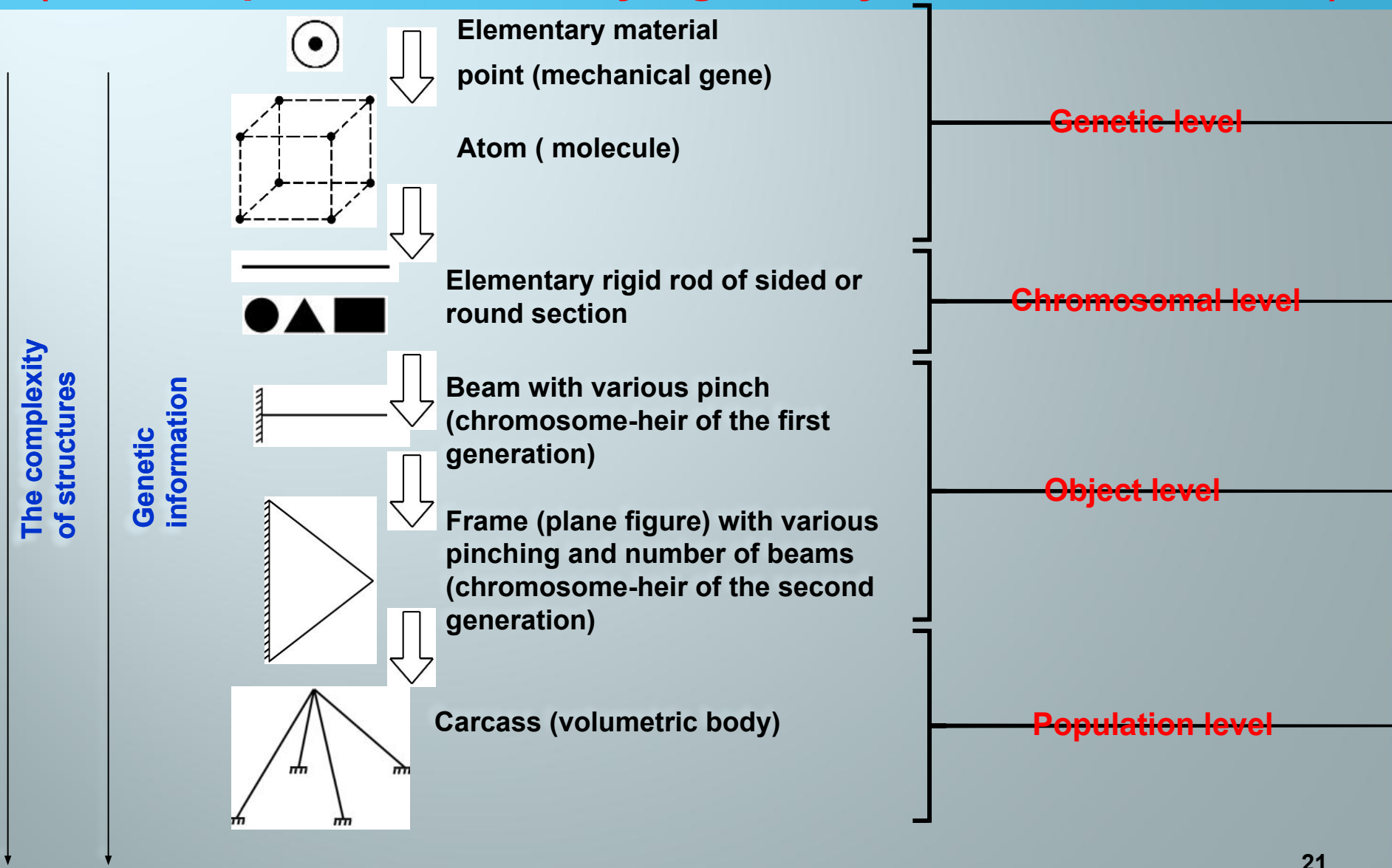
# Main areas of knowledge, systems, threads and energy transformers used to create machine tools

<b>Field of science</b>	<b>Name of the system and functions</b>	<b>Threads</b>	<b>Energy transformers (ET)</b>
Building mechanics	Support system	Gravitational	Absent
Applied Mechanics	Mechanical, transfer motions and loads	Kinematic, force, energy	Mechanical (MBE)
Electromechanics	EM - a system of movement and load transfer	Electromagnetic, power, energy	Electromechanical (EMPE)
Hydromechanics	GM - a system of movement and load transfer	Hydraulic, power, energy	Hydromechanical (GMPE)
Aeromechanics	AM - a system of movement and load transfer	Air, power, energy	Pneumomechanical (PMPE)

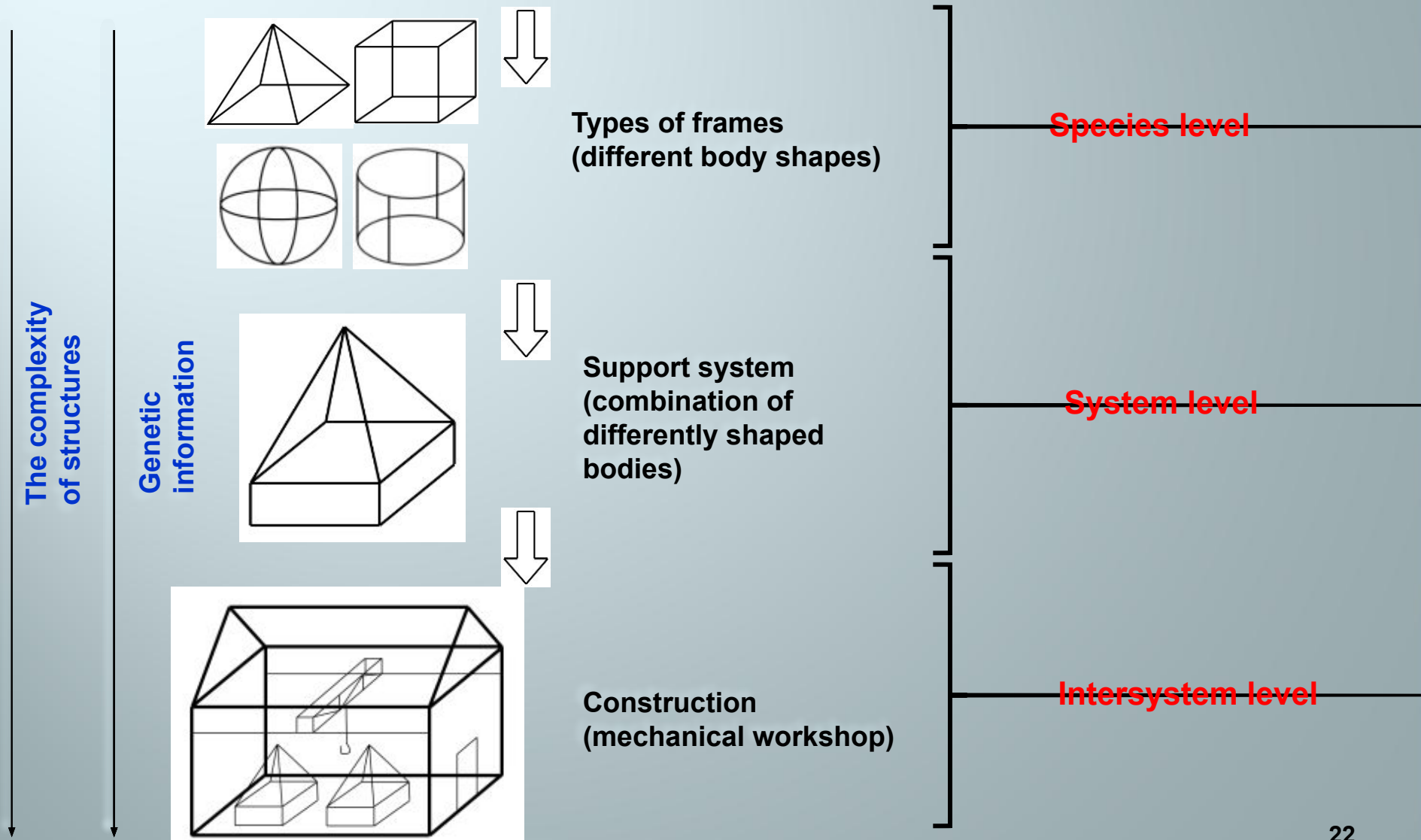
# Main areas of knowledge, systems, threads and energy transformers used to create machine tools

Field of science	Name of the system and functions	Threads	Energy transformers (ET)
Thermomechanics	TM - a system of movement and load transfer	Heat, power, energy	Thermomechanical (TMPE)
Biomechanics	BM - a system for a motion and loads	Biological, thermal, chemical, power, energy	Biomechanical (BMPE)
Electronics	Electronic transmission of control signals and control	Electronic, Information	Electronic (EPE)
Acoustics	Vibroacoustic, the transmission of vibrations and sound waves	Electronic, acoustic, energy	Vibroacoustic (VAPE)
Mechatronics	Mehanotronic, transfer motions, loads, control signals	Kinematic, force, energy, electronic	Electromechanical (EMPE) Electronic (EPE)

# Genetic model of composition and development of the supporting system structure (on example, of elementary rigid body in the form of a rod)



# Genetic model of composition and development of the supporting system structure (on example, of elementary rigid body in the form of a rod)

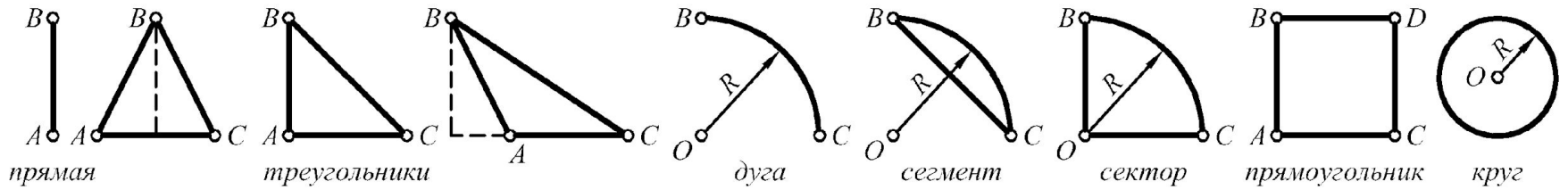


# Liason between genetic and geometric operators of synthesis TS

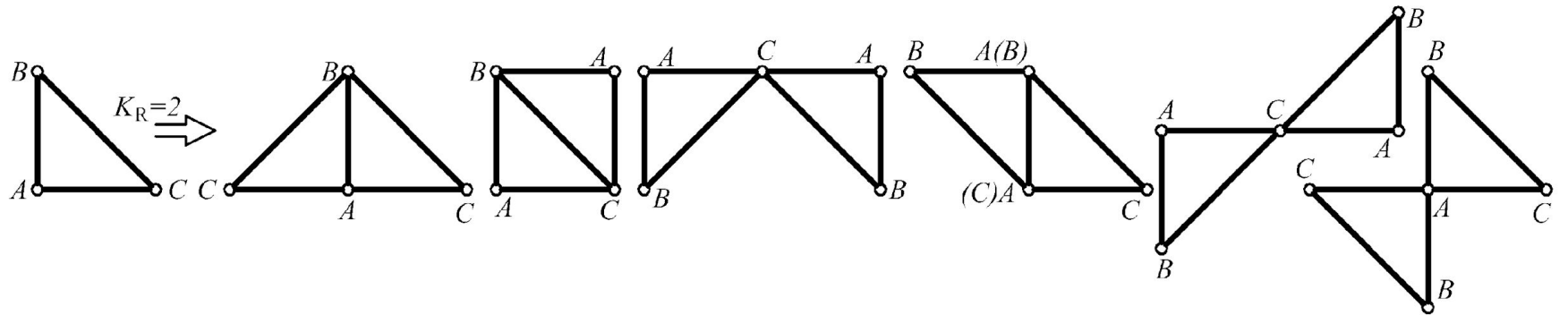
Genetic operators	Geometric operators
<b>Replication</b> (chromosome, object)	Doubling, multiplication, broadcast, versatility, multi-ribal, multifaceted, multi-position, multiinstrumental
<b>Crossing</b> (monohybrid, dihybrid, polyhibrid)	Spatial association (complete, with displacement, with the rotation, and zoom; raznofigurnost; multifunctionality)
<b>Inversion</b> (spatial, elecromarnetic)	Spatial rotation of 180 °; eversion figures on the reverse side
<b>Crossingover</b>	Sliding parallel transport; mirroring transformation antisymmetry decussation
<b>Mutation</b> (spatial, kinematic, electromagnetic, elastic stress-power, material)	Spatial deformation and voltage scaling, change of flow, the transformation of forms, states, properties, fields



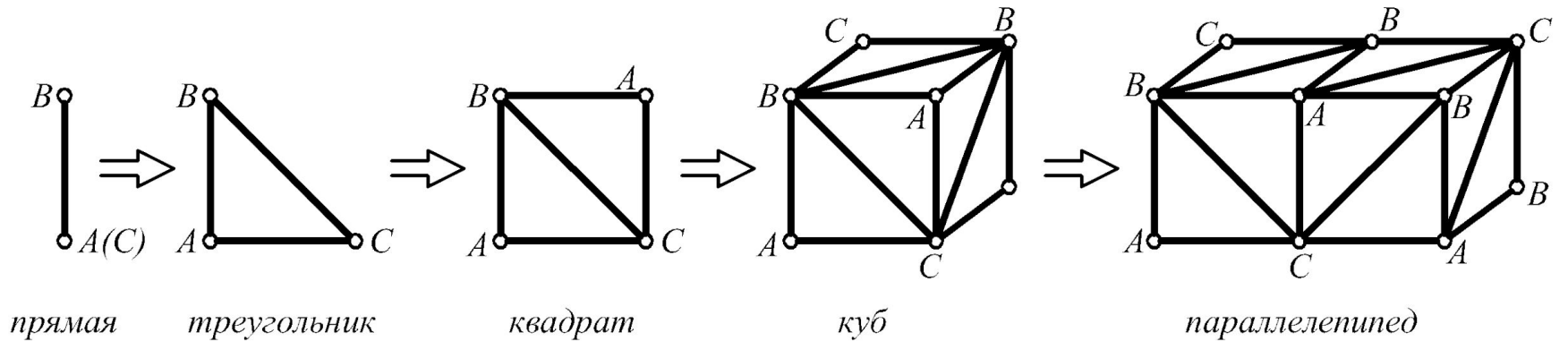
# Geometric transformation operators of layouts machines (carrier systems)



## Parental "chromosomes" (primary geometrical figures in the course of genetic synthesis)



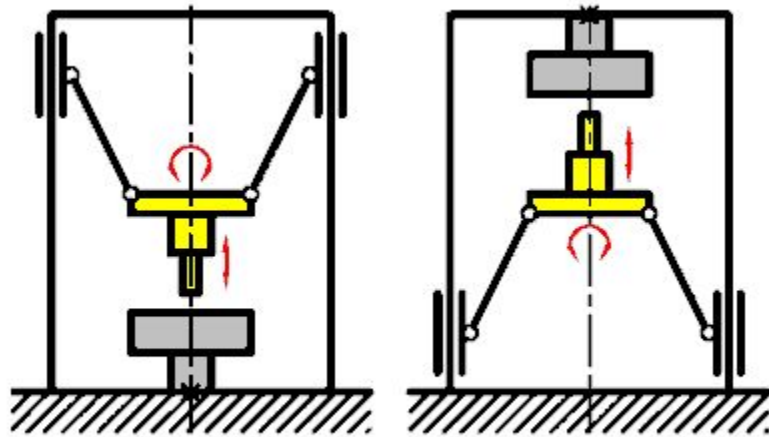
## "Chromosomes"-descendants (spatial combinations of two and more "chromosomes")



## "Chromosomes"-replicators (generating new forms in procedures of replication) <sup>24</sup>

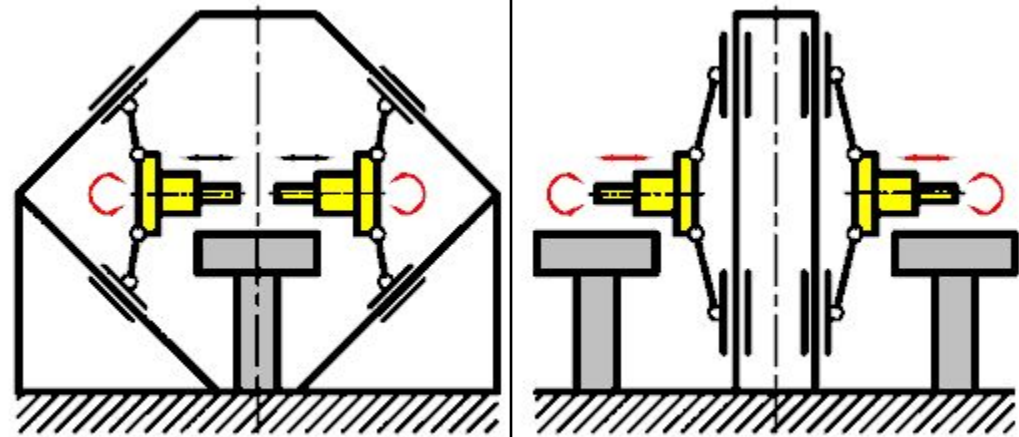
# «Chromosome» inversion

Single-layout



*повернуто на 180°*

Multi-layout

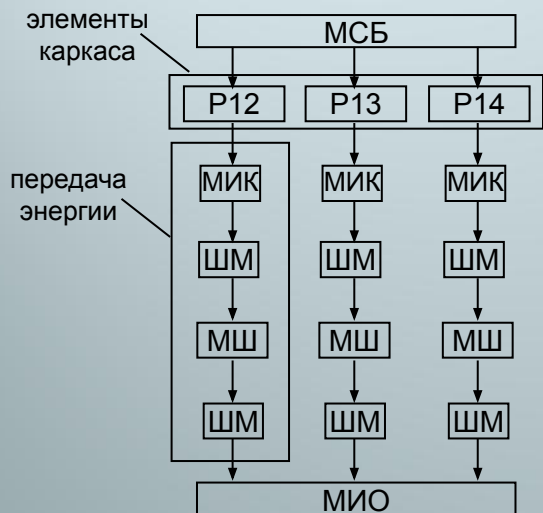
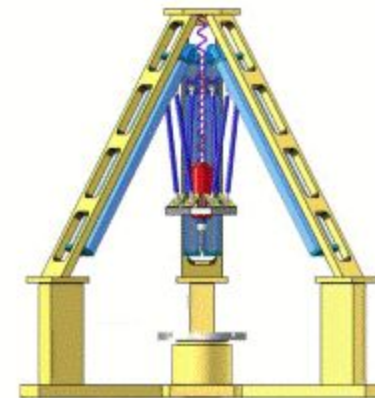
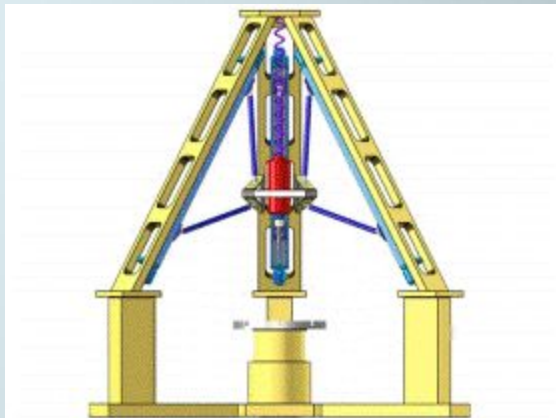
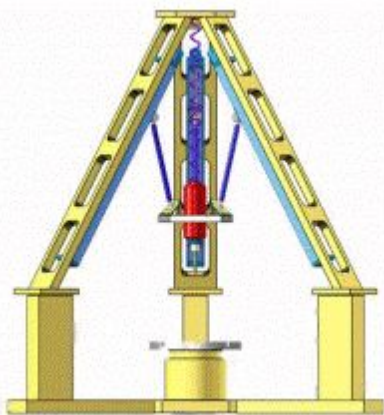


*вывернуто наизнанку (на 180°)*

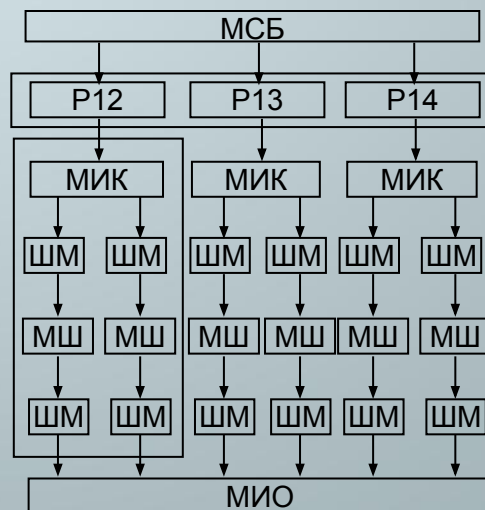
***Variety turned chromosome structure – instrumentation systems on mobile platforms***

# Drilling and milling group

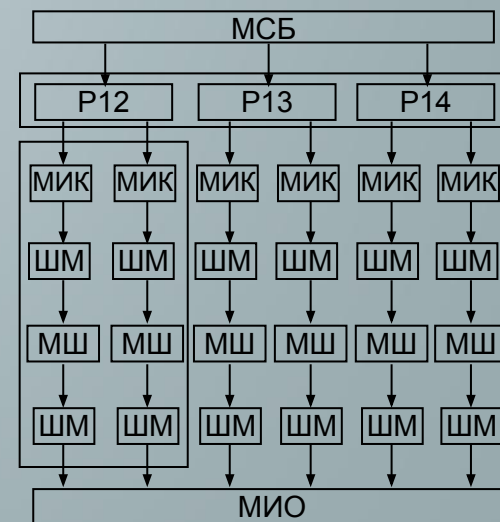
Patent of Ukraine № 86533



W=3



W=6



W=6

# The support frame and tool systems Drilling and milling machines with configurations of parallel kinematics

27



***four faces***



***three faces***

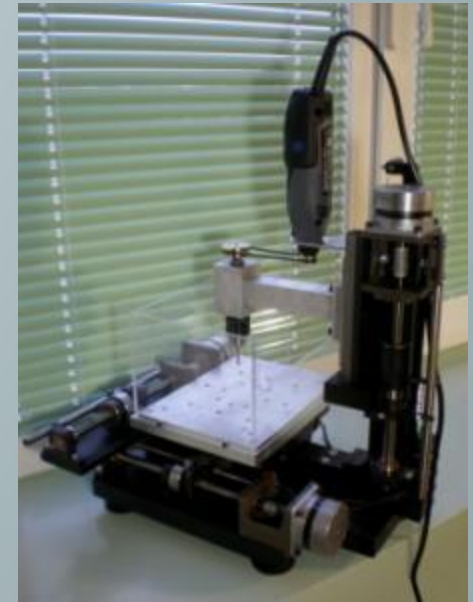
***Designs are protected by 26 patents of Ukraine***

27



# The wedge assembly bench milling machine with a mechanism of parallel structure, controlled by computer

28



28

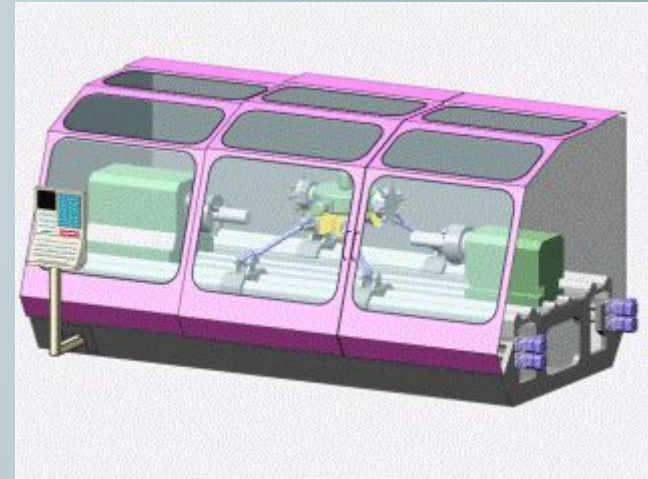
# Lathe tools with parallel kinematics ("spiders") hybrid layout

29

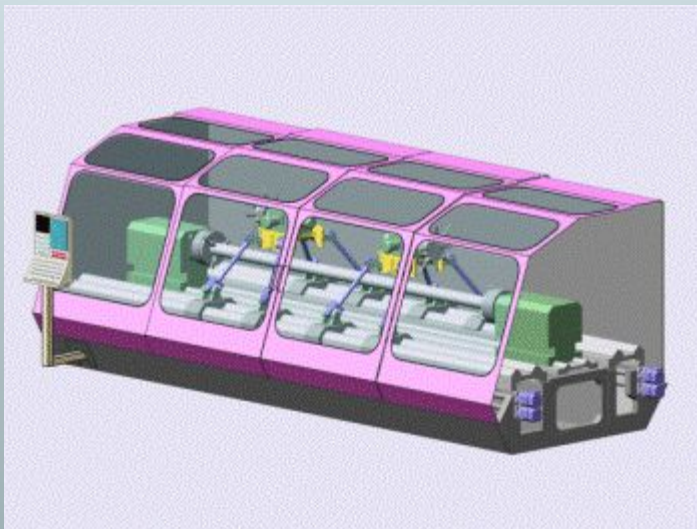
a)



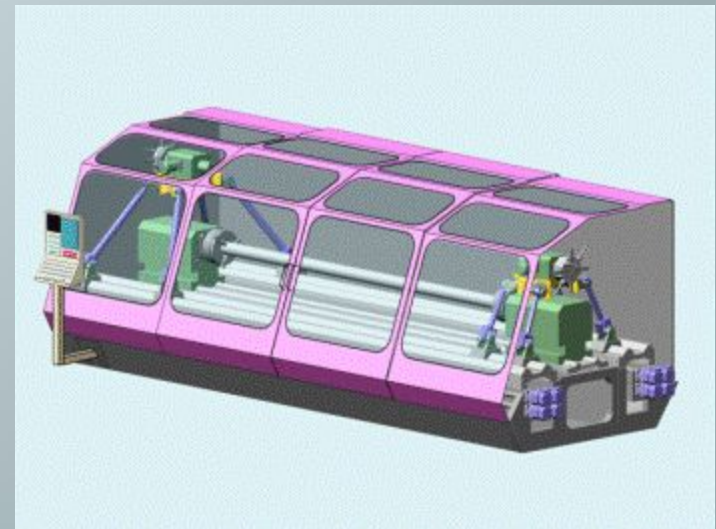
b)



c)



d)



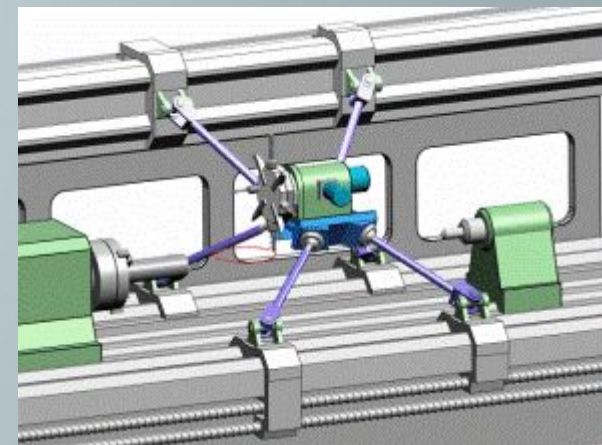
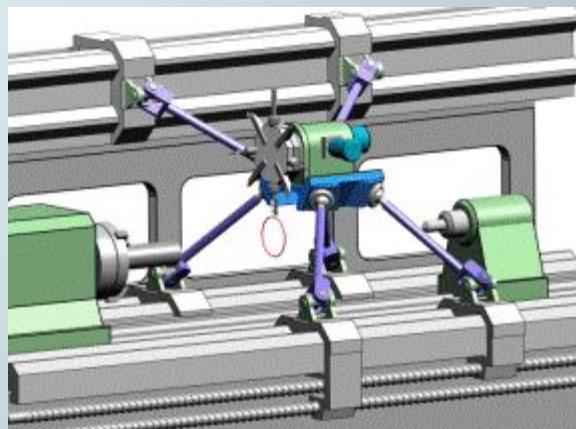
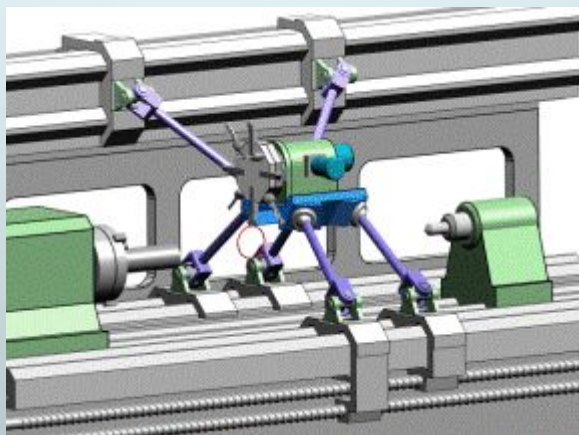
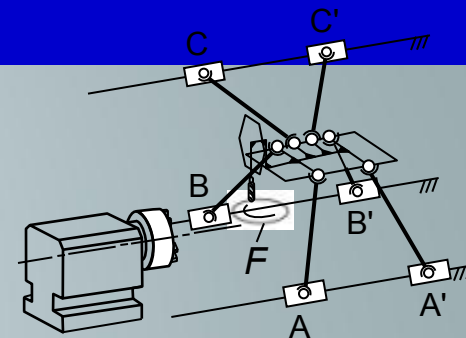
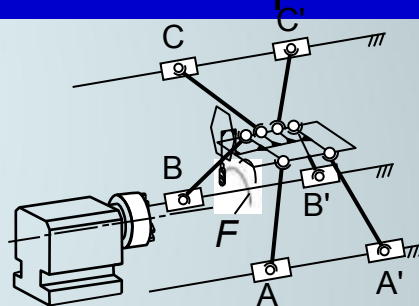
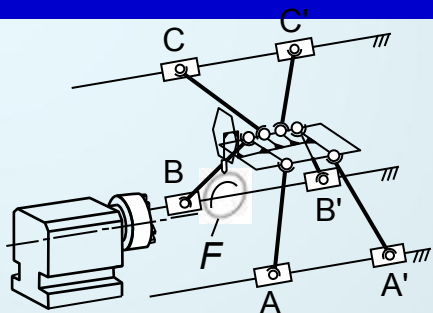
*Designs are protected by 12 patents of Ukraine*

29



# Processing along the arc of a circle

(circular interpolation)

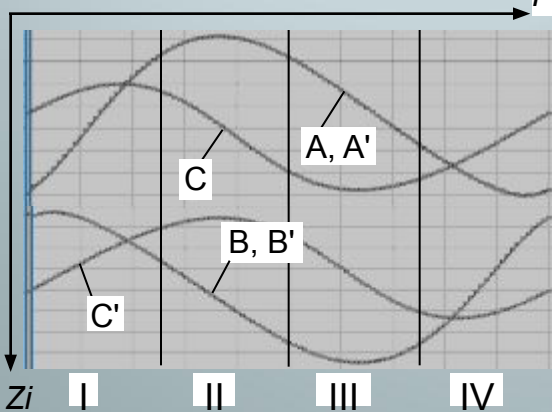


траектория инструмента, %  $F$

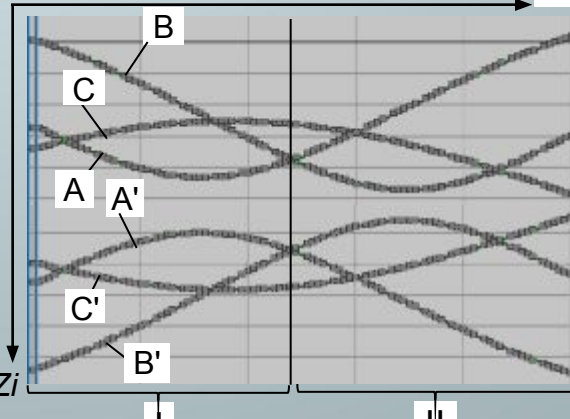
траектория инструмента, %  $F$

траектория инструмента, %  $F$

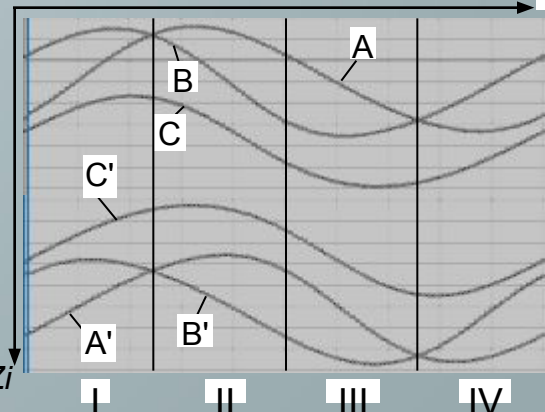
положение каретки на направляющей



положение каретки на направляющей



положение каретки на направляющей



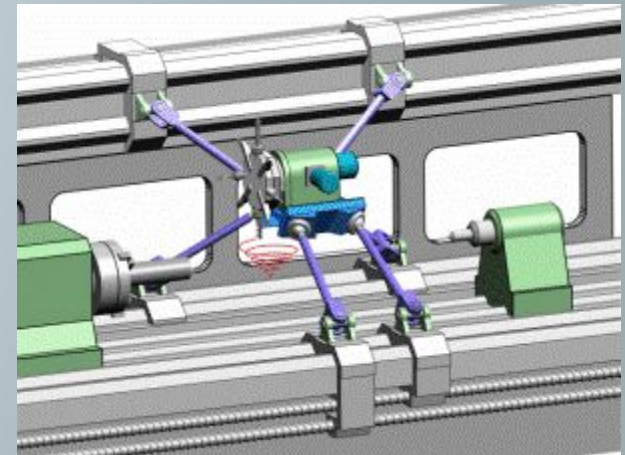
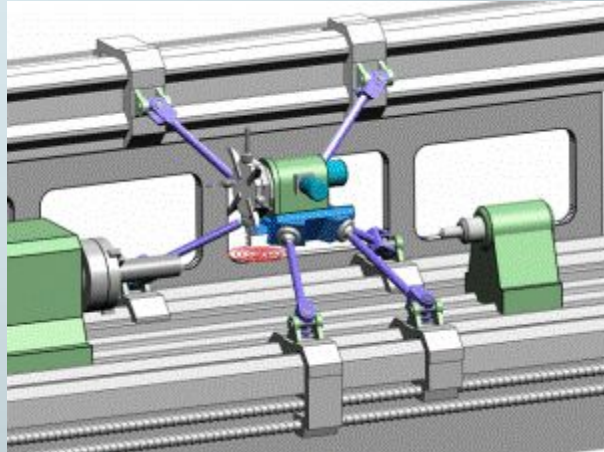
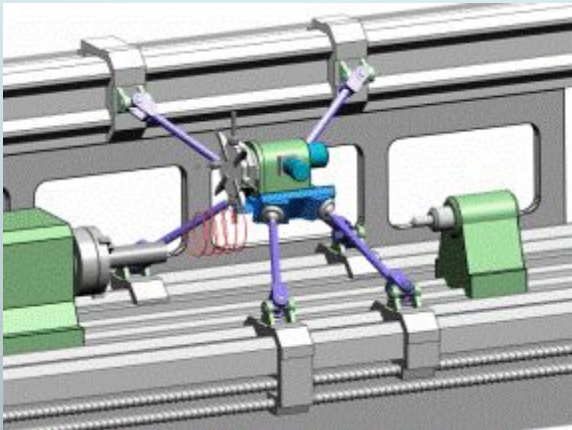
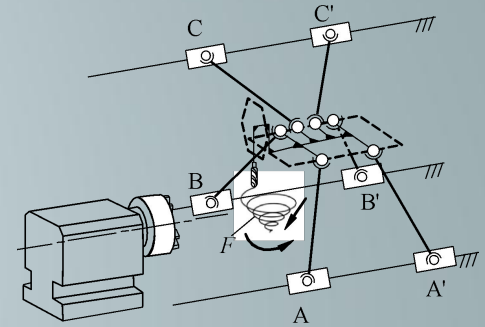
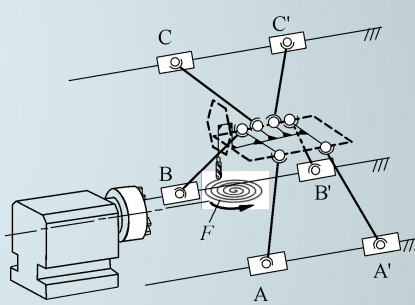
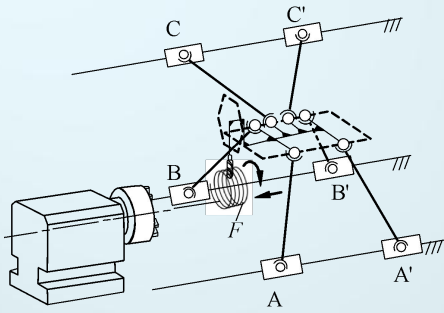
Четверти окружности

Четверти окружности

Четверти окружности



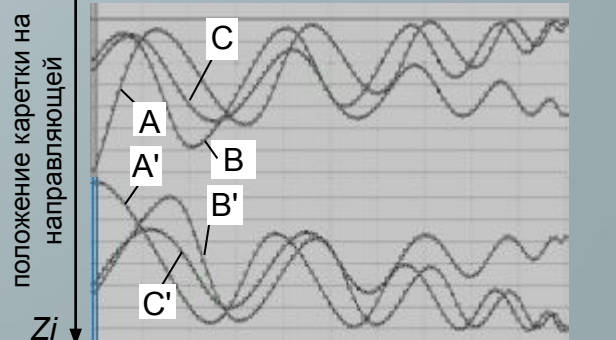
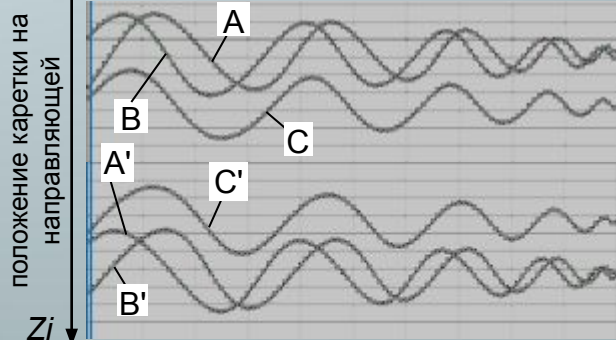
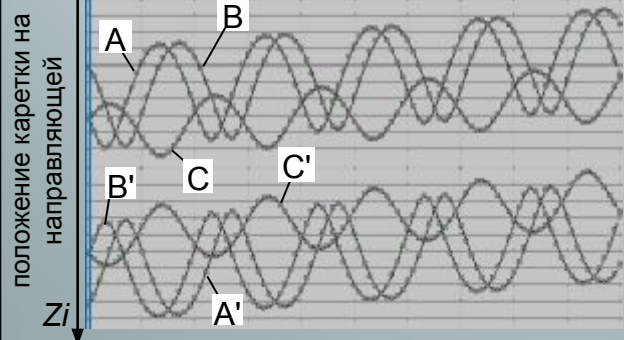
# Cutting path of the helix



траектория инструмента, %  $F$

траектория инструмента, %  $F$

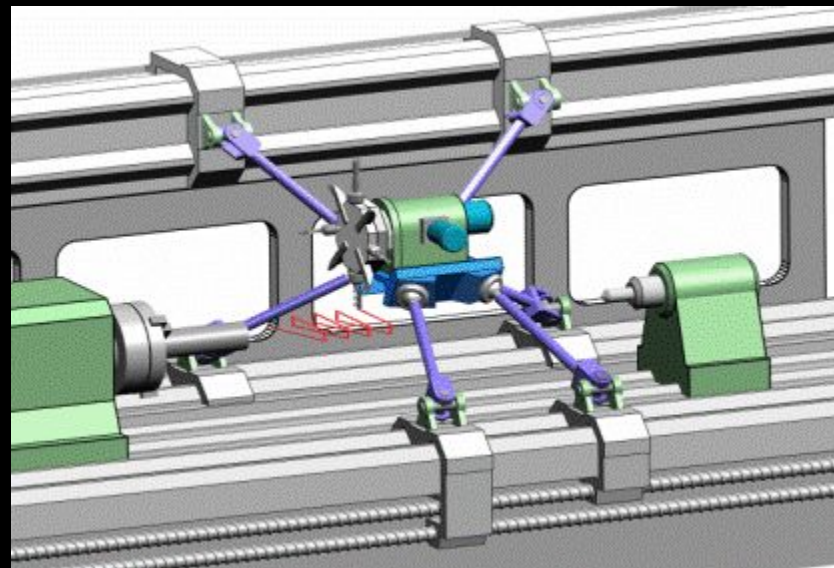
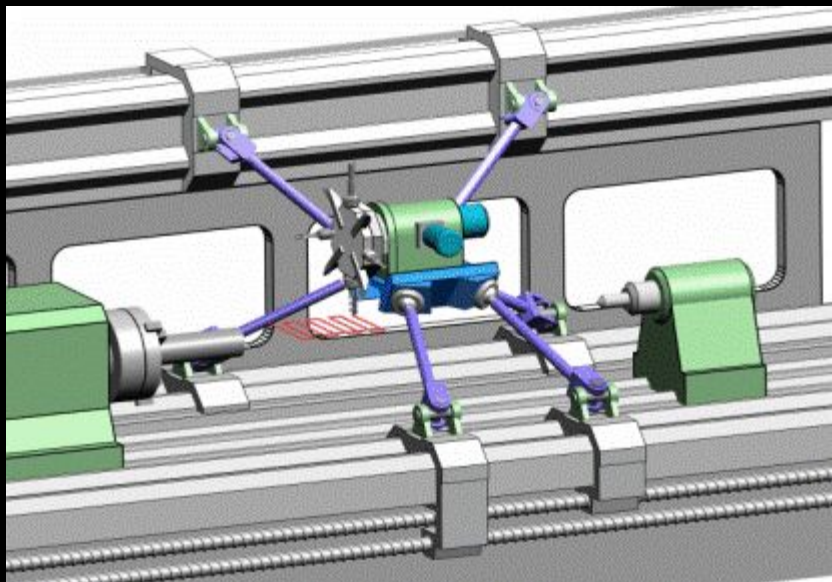
траектория инструмента, %  $F$



# Typical schemes of milling planes

## “Zigzag”

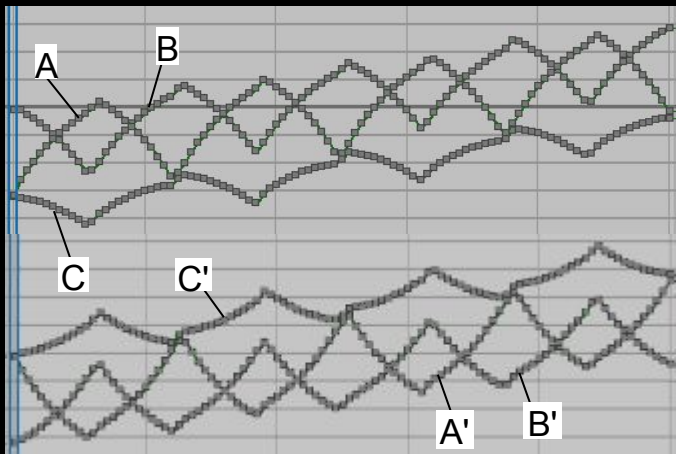
## “Loop”



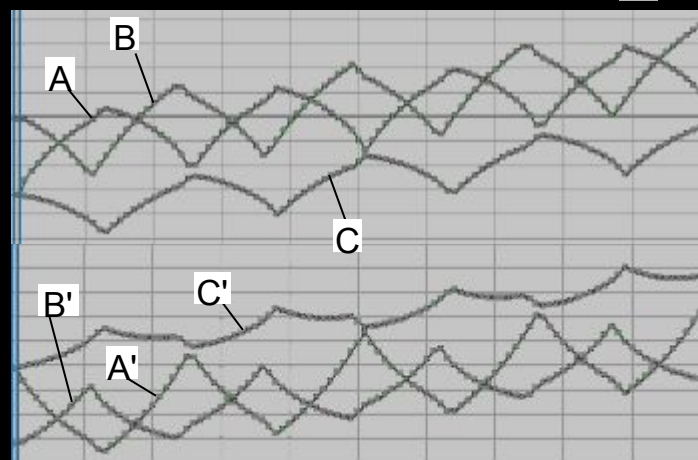
F

F

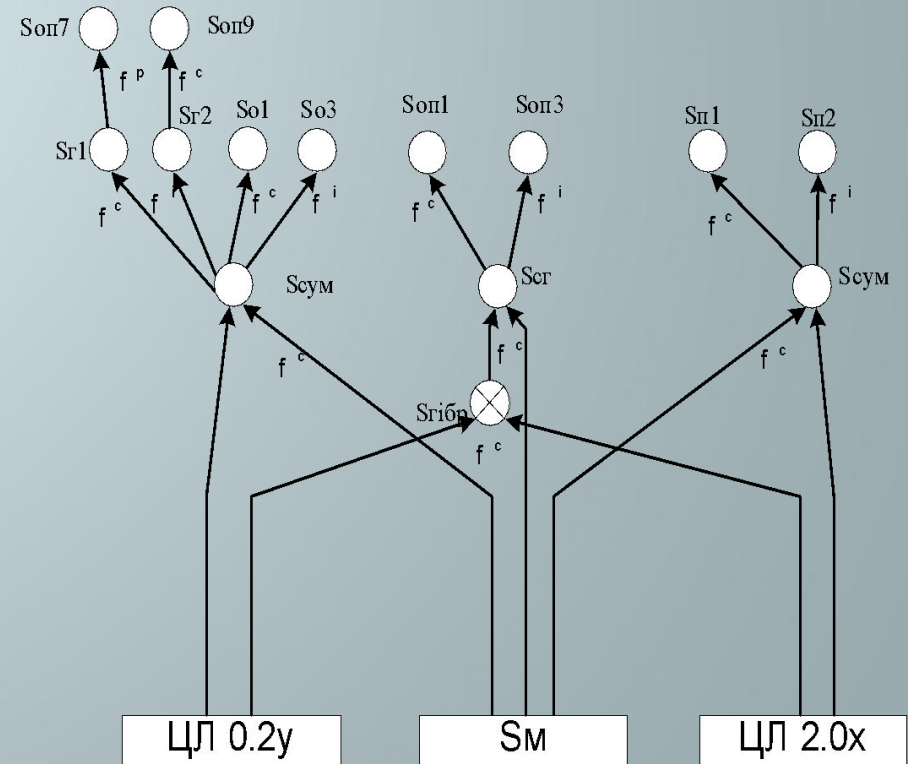
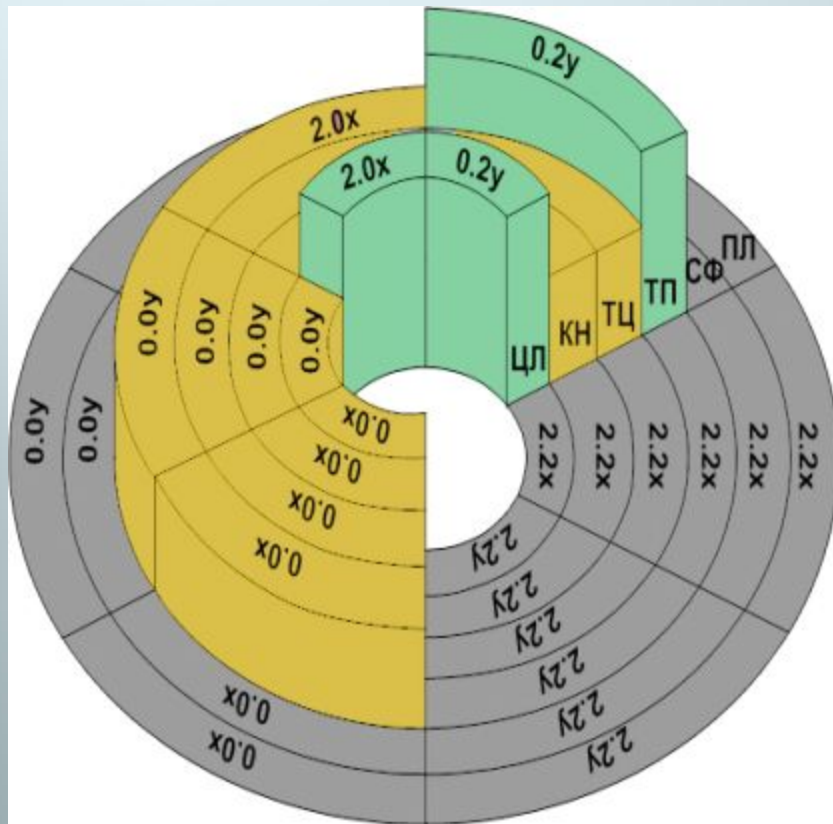
положение каретки на направляющей



положение каретки на направляющей



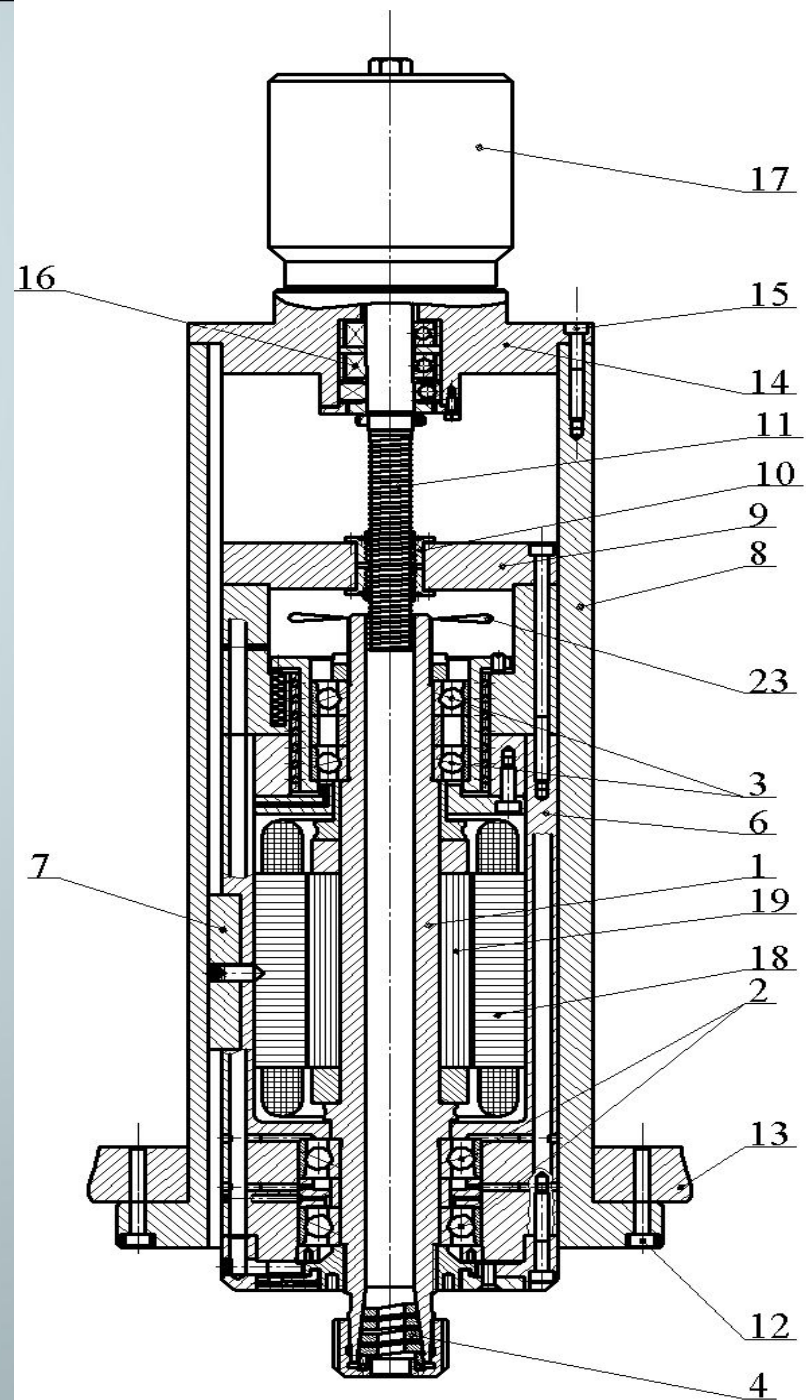
# The domain of existence and construction of a genetic model for construction of the motor-spindles





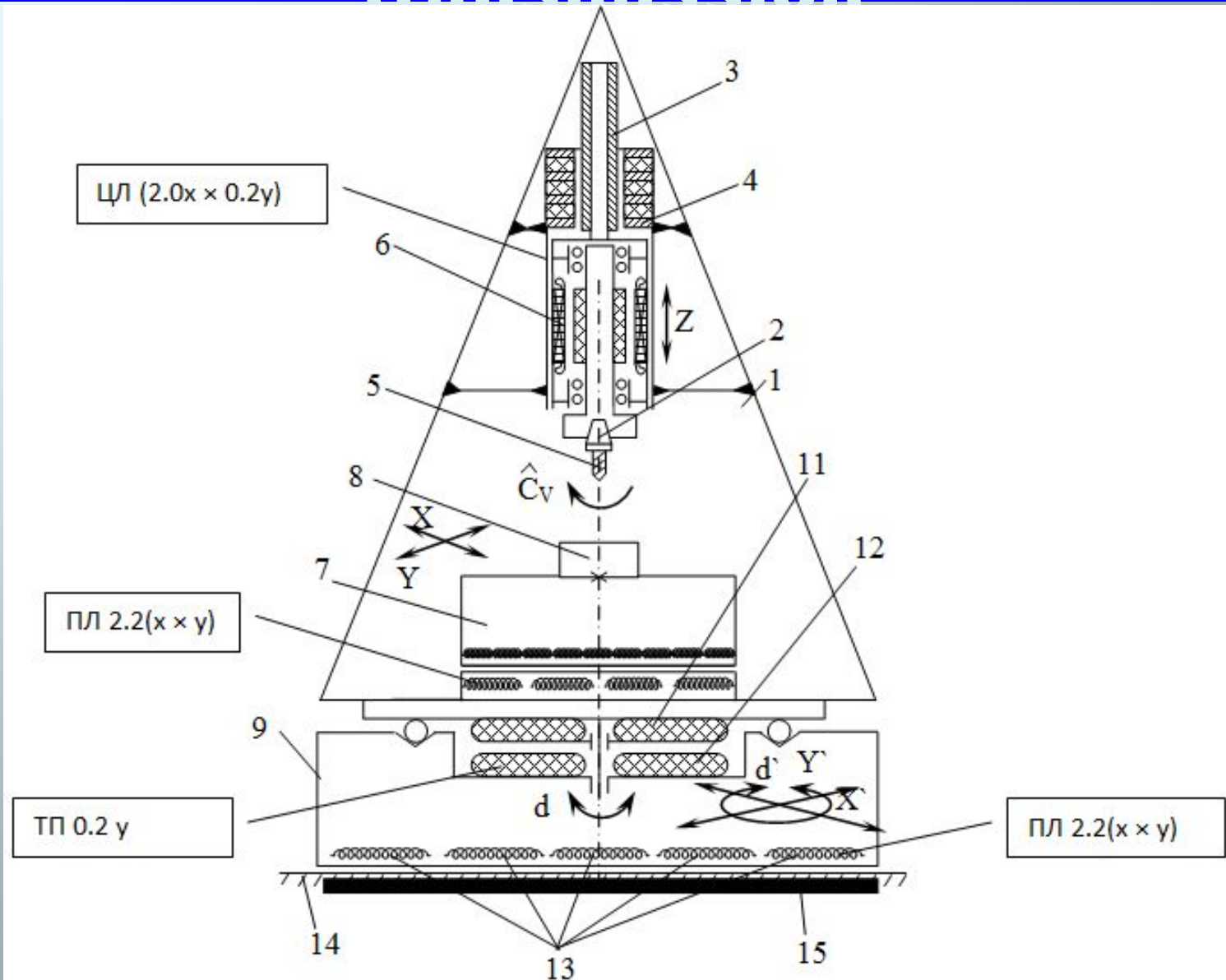
# Variant embodiment of the synthesized spindle motor

coaxially with the actuator supply (the genetic code (ЦЛ 0.2 \* Sm) \* ЦЛ 0.2y): 17 - stepper motor supply, 11 - ball screw 23 - Fan 6 - quill, 1 - spindle, 19 - rotor, 18 - stator, 8 - Housing 13 - rotor system of the machine, 4 - tool chuck



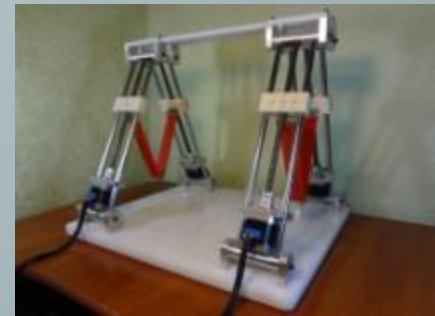
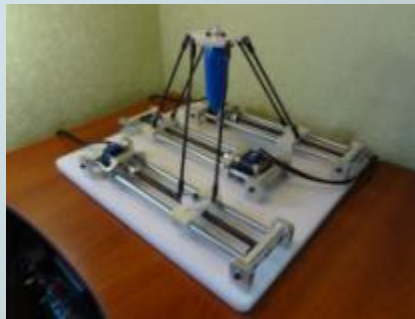
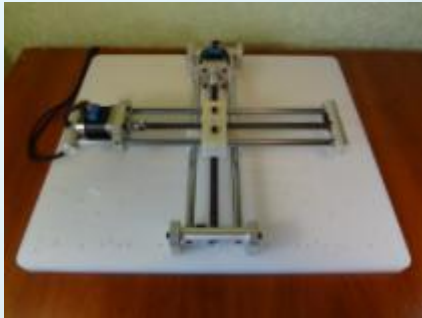
# Multi-axis drilling and milling machine of high mobility without mechanical transmission

35



35

# Modular desktop CNC machines



To watch the video, visit:  
<http://www.youtube.com/watch?v=wkk4zv96Dvo>

## Our laboratory of desktop CNC machines





**Thank you for your attention!**

**With best regards,  
Yuri Kuznetsov and his team.**