ALTERABLE IN TIME TRANSFORMATION OF AGGRIGITIVE STATE OF MACHINE SYSTEM WITH CHANGEABLE STRUCTURE AND COMPONATICS ON BASIS OF AUTOMATICALLY RENEWABLE PRISMATIC MODULAR UNITS

Abstract It is represented the scientific Statements of Aggrigative State of Machine Systems with changeable structure and componatics with usage of automatically interchangeable and renewable aggregates and modular units. A Recomponation and units change Automation on various structural levels are main properties of the time – invariant transformation of aggregative state Machine System and their exploitation parameters.

KEYWORDS: MACHINE SYSTEMS WITH CHANGEABLE STRUCTURE AND COMPONATICS, AUTOMATICALLY INTERCHANGEABLE AND RENEWABLE MODULAR UNITS

Introduction. One of direction of increasing of Manufacture effectiveness it is become the creation of Mechatronic Automatic Manufacturing Machines (MAMM) possessing by properties of Structural and Componatic Transformation and of Componatics Changing. The Recomponatics is necessary property of MAMM Flexibility to change and transform the Componatics in process of structure changing in a coordinated fashion with transformation of technological process structure and work – piece machining. The Recomponatics is directed to changing of MAMM Configuration, its overall view in changing process of units space orientation, relative allocation, basing and clamping. In Componated Status of MAMM it is performed production process, conjoint functioning of units and mechanisms, performing technological functions.

The MAMM appearance as scientific direction reply to contemporary tendencies and development strategy Multivariant Production in optimal range of production program changing from Mass to Individual Productions.

The Aggrigative State Transformation of Machine Systems on Basis of Automatically Renewable Prismatic Modular Units

MAMM with Aggregation Principle and properties variability of MAMM Machine Systems changeable structure and componatics are named as Recomponatable Manufacturing Systems (RMS1) [11,12,13,17,19,21,22] and in contradistinction from Reconfigurable Manufacturing Systems (RMS2) [32,33,34,35] are based on distinctive characteristics such as multiplicity and multivariation usage and modules goal destination, changeability of units bases and allocation and clamping places in Recomponation process. In fulfillment of production process with usage Recomponatable Manufacturing Systems (RMS1) there are performed the control by material, energetic, information and product flows varied in real time. With usage of aggregate composition and automatic changing Machine System aggregate modular units it is decided problem of life cycle increasing and problem of Manufacturing System Rejuvenation and Renewal [21]. The Recomponatable Manufacturing Systems (RMS1) are related to the Avant-Garde Manufacture Technologies (AMT) of Machine – building industry evolution. The RMS1 is constituted the main field of contemporary Manufacture development that they might be not only readjusted and had the automatic mechanisms for tools changing, but might automatically change the Componatics and Structure in real time and they might be compensated from various aggregates and modular units and be recomponated with decision of concrete production task don’t stopping continuous process of technology changing. These RMS1 Machine Systems presuppose new possibilities of industrial contradiction overcoming when time factors: dates of realization, attainment of quality and quantity production are defined by requirement of all growing rivalry and business struggle [18]. The Recomponation is become by necessary flexibility property to change and transform the Structure, Composition and Componation in process RMS1 Machine System changing in correlation with technological process structure transformation of work – pieces production [10,13,15].

The hierarchy system of aggregation is composed the base of multilevel RMS1 Componation from automatically changing modular units [12,13,15,23,24,25,26,27,28]. In common case for each two units, forming hierarchy aggregation subsystem, one from these units of the most hierarchy level is by basic elsewise bearing (carrier) unit, i.e. is revealed by bearer towards to units of smaller level of structural hierarchy. The bearer y structural hierarchy level is aggregate or modular unit serving for allocation on them unit (units) and mechanisms of y - l level in RMS1 structure for performing conjoint technological functions.

Viewing the bearers as automatically changing aggregates and modular units, there are separated two group of Componation branches on RMS1 work station. 1. The branch (branches) joined bearers, units, aggregates for technological and multitools action on work – pieces. This branch is named – the Machining Tools Branch (MTB). 2. The branch (branches) of bearers, units and aggregates for basing and clamping of work – pieces. This branch is named – Work – Piece Branch (WPB).

RMS1 Componation elements are revealed by automatically changing modular units of technique means complex [9,10,12,14,23,24,25,26]. The modular units are represented by single – level aggregates and modules for multilevel composition on various levels of structural hierarchy. The componated multilevel aggregate are stated by RMS1 technological complete. The technological complete, allocated in production componation space, is formed work station of technological and transport componation branches [17,28].

The aggregate formation principle of automatic Manufacturing Systems don’t be new [1,2,3,4,8,10]. On its basis there are designed and created the Transfer Lines, Aggregate Machine Tools, Flexible Manufacturing Systems, Flexible Manufacturing Modules [4,5,6,7].

The Main Aggregation Principles of Recomponatable Manufacturing Systems (RMS1) relative to Avant-Garde Manufacture Technologies (AMT)

1. The principle of differentiation and concentration processes combination for machining work – pieces [10,14,15,17]. The performance of this principle is fulfilled to provide the machining of several work – pieces allocated on lateral sides (planes) of bearer including:
   - multisided machining;
   - multicoordinated machining;
   - multiplace machining with allocation of basing and clamping places and points for work – pieces in various coordinate planes of bearer;
The distinctive feature for exit to decision of these tasks is revealed the usage in RMS1 of bearers, frame of which is performed in view of orthogonal prism. For these bearers of prismatic form it is provided the possibility of work – pieces machining allocated on various planes of prismatic bearer body frame in clamp fixtures with input of machining and tools units, with various sides to work – pieces on various bearer planes [23,24,25,26].

The bearer, fig. 1, frame of which is performed in view of orthogonal prism- of cube has six planes 2 [23,24,25,26,29,31]. The allocation place on side planes 2 of work – pieces 3, clamped on platens – fixtures 4, is defined by constructions bearer, operating area (work zone) 5 of tool influence (tools machining). The allocation of work zone 5 corresponds to work – pieces 3 on side planes 2. If there are 6 planes then must be six work zone 5. Every work zone as operating area is defined by dimensions of allocation outline with possibilities of multicoordinate tools input towards to work zone 5 and work zone sides. Consequently, the allocation space of work – pieces 3 above platen 4 surface and side plane 2 is situated in work zone 5 tool influence.

On figure 1 by arrows it is showed the variation of multicoordinate and multitools influence and machining directions. In that case there are achieved a various schemes of RMS1 work stations Componations and various schemes of multitools, multiplaced and multisided machining in simultaneous operating work – pieces on several planes faced to tools on RMS1 work stations [28,29,31].

**Fig. 1. The scheme of multivariant, multicoordinate and multitool influence to work – pieces clamped on bearer side planes**

The work – pieces (details) 3 allocated on side plane 2 define in common the multiplaced basing and clamping on bearer frame and if necessary it is allowed the multiplaced allocation of several work – pieces on each plane. In is provided the design practice typing of bearer frame 1, scheme typing of coordinate and space allocation work – piece 3 on platen – fixture 4 with side of bearer planes 2, typing of work zones 5 relative to bearer, scheme typing of tool influences for RMS1 various Componatics.

The number of tools influence \( n_{m} \) equal to planes number \( n_{p} \) on bearer frame. In common case the allocation sequence of work space – pieces 3 from plane 2 of bearer 1 is remained opened on each plane 2 for tools input to work – pieces 3 with five sides and directions. The work – piece coordinate system and work zone 5 is attached to the bearer coordinate system.

The tools of machining units on RMS1 work station are grouped together towards to work zone 5 with possibility of multitools influence grouping [28,29,31]. To every work – piece 3 on side planes will correspond peculiar tools group of machining units for each RMS1 work station.

2. The multilevel automation changing principle of bearers, units and mechanisms [9,17,22].

The multilevel automation changing principle of bearers, units and mechanisms is defined by necessity of RMS1 Reacomponatics and automatic Componation on various levels of aggregation, by constriction of nonproductive time on the Reacomponatics and changing of work – pieces and modular units.

The bearers are revealed by automatically changing RMS1 units and in many ways define RMS1 Componatic modifications [23,24,25,26,28,29,30,31]. To number of main bearers features influencing on RMS1 Componatic generations may relevant:

- coordinate allocation and mating feature of aggregates, changing modular units and bearers in RMS1 Componation space;
- the feature of bearers distributive basing system on RMS1 work stations;
- the feature of orientation and motion directions formations for transportational, technological, material flows;
- the feature of aggregates functioning sequence.

3. The principle of distributed basing and basis changing automatization [15,17,20,30].

For principle of distributed basing it is considered the bearers basing with multivariant properties of basing and clamping on RMS1 work – station of units, mechanisms of bearer side planes.

The technique decisions foresee the bearer modification with basing elements from of all frame side admit the usage and allocation changing of frame side planes for mating with aggregates on work stations and with transport branches allocated in various coordinate surfaces and directions. The availability of basing elements on bearer frame side planes lead on work stations to mating of other bearers and modular units with side transported bearer various planes [24,25,26].

4. The principle of multicoordinate and multisided direction for bearers motion in production space and on area of RMS1 Componatics. In performance of this principle there are increased combinative possibility of bearers allocation, basing and clamping in time of transport motions and machining [17,23,24,25,26,31].

These RMS1 properties are considered on performance base of multicoordinate, multisided direction for bearers motions principle [23,28,31]. The considered properties of bearer universal moving principle , fig. 2, [23] create the conditions of multicoordinate moving and mating as bearers so and modular units in RMS1 Componation space. It is expended the compositional forming – up number of technological and transportational flows and their positions in space system of axes.

**Fig. 2. The multivariation of bearer positions , directions space motions and interstations transporting on RMS1 work stations where bearers are performed in view of prismatic form modular unit**

In process of performance of this principle there are expanded combinational possibilities of bearers basing and clamping in transporting and operating time. The RMS1 obtain following properties: 1) multicoordinate space motion of bearer and directions multivariation of bearer transportational moving without its turning around, fig. 2; 2) the mating with multicoordinate allocation of bearers and modular units relative to bearer frame various planes on RMS1 work stations [23].

The outer planes of bearer frame serve not only for basing and clamping work – pieces on various sides but and for conjoint bearers, modular units basing and clamping among themselves, for their transporting in process of changing and movement. The bearers integration in the presence of variable mated surfaces together with basing, clamping, transporting equipments is...
generated the Componatic decisions variation of RMS1 work stations. The correlation of bearer frame sides among themselves in the presence of connections lead to consideration of conjoint allocation and Componation places. With bearers usage for RMS1 there are realized the variable properties as technological so and transporting flows, there are performed the changing of materiel and informative flows, of production organization and control [12,17]. There are changing RMS1 structural parameters, such as variable, number of work stations from technology aggregate kits and of parallel technology kits, Componatic branches flows.

The Automatically Renewable Prismatic Modular Units and their influence on RMS1 Componation
To number of RMS1 main modular units there are related the bearers performed in view of hollow multiplane prism [17,22,23,24,25,26]. The bearer is revealed by automatically changing transport - technological device that on side planes frame or inside frame there are based and clamped the work – pieces and actuating units, fig 3, [26]. For providing of the most work – pieces machining process concentration and of fixture and tools allocation on side planes in maximal differentiation of operations the multiplane bearers allowed to model and create the most optimal RMS1 Componatics [14].

The bearer has \( n_{gr} \) – quantity of planes with outer side prism frame. This quantity characterizes the side plane number of bearer frame for basing and clamping of blanks with their following machining. For bearer, fig 3, \( n_{gr} = 6 \), [17,26]. The work – pieces allocation on planes is provided the accessibility of tools group input in direction of tool machining to any plane from six planes.

As far as the work – piece on side plane is undergone to tools machining with possibility of multicoordinate direction and tools input and bearer allow to perform the work – pieces multisided allocation on side planes that there are achieved the multilacement of work – pieces, many-sidedness and multitoiling machining simultaneously of several work – pieces on various bearer side planes. On side planes there are performed the base holes for distributive basing of any frame plane relative to RMS1 work station [24,25,26].

Mating lead – up directly between machining units bearer and work – pieces bearer provides kinematical connection between basic parts of machining unit and work – pieces clamping fixture, foreseeing in Machinery time [26,28,31]. Kinematical connection increases structural stiffness in machining process and accuracy of work – pieces production. The kinematic fastening of machining units bearer is admitted with sides of all work – pieces allocation bearer frame planes [20].

Located bearers of tool machining units and bearers of work – pieces on base bearers – housings and beddings the kinematic fastening will be characterized by flexible mating of units relating to technological influence, tools branch and to work – pieces basing and clamping branch. Using distinctive properties of bearer and on basis of considered principles there is possibility to perform the multivariation bearers connection of various branches, fig 4, [28,30].

The presence of advanced supporting surfaces on bearer frame side planes give the basis for perfection of bearers basing, clamping automatization and among yourselves that there are decided the tasks of stiffness and accuracy increasing. The lead – up of mating immediately between bearers of tool machining units and work – pieces provides kinematical connection between basis parts of machining unit and work – pieces clamping fixture in operating time. to work – pieces bearer the kinematical fastening is admitted with side of various bearer frame planes, fig. 5 [17,29].

Conclusion
The bears application of prism form expand the RMS1 technological possibilities, give to RMS1 the new technique – exploitation feature:
- multisided allocation of work –pieces and mechanisms on side planes of bearer frame, providing the multiplaced work – pieces machining with side of various planes;
- multisided workpieces machining, opening access of tools in side of each plane to work – pieces on planes and to work zones of allocation work – pieces on various planes in machining process;
- multitool machining with the help of tools group of several work – pieces in any direction of tool influence towards any from six side planes.

The received RMS1 technique – exploitational properties defined the technique - economical advantages of RMS1 creation relation to contemporary Manufacturing Systems (FMS, FMM, FTL, TL and others). First of all it is decided with usage RMS1 the following production problems:
- flexibility increasing of Structural and Componatic transformation and RMS1 usage in conditions of Reconfigurable Production;
- flexibility increasing of work – pieces nomenclature changing, Production Capacity, exploitational reliability;

Fig. 3. The automatically changing the modular unit – bearer of prism form for basing and clamping of work – pieces, work tools, fixture, actuating mechanisms

Fig. 4. The Componation of RMS1 work station with application of bearers tool machining units and work – pieces with one – sided mating of bearers

Fig. 5. The Componation of RMS1 work station with application of machining units bearers group and of work – pieces bearer with multisided connection of bearers
- increasing machining accuracy and Manufacturing System stiffness, decreasing cost and production area;
- improvement of working conditions and decision of ecological problems;
- possibilities increasing of aggregate regeneration of working ability and rejuvenation in respect physical wearing and moral ageing;
- decreasing of RMS1 cost and accordingly of labor costs relative to FMS.

The automatization of RMS1 Structural and Componatic transformations is appeared as major link of automatization working ability and rejuvenation in respect physical wearing and ecological problems;