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THE INSTRUMENT OF FORMALIZATION AND SYNTHESIS OF NEW STRUCTURES OF KNITTED FABRICS

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In development of the work [1] we want to show efficiency of the instrument of the formalized description developed by us and synthesis of new interlacings. Thus we shall emphasize a special urgency of productive thinking presently, meaning that 2009 in ES is declared "the Year of innovations and inventions".

Formation of properties and providing of quality of knitted production, creation of new "product line" of assortment of products is carried out in system whose basic elements are a textile fiber, a thread (yarn), a knitted material (fabric) and a design of a product. The account of all factors in the complex (system) approach to design of products essentially expands opportunities updating of production and maintenance of much wider spectrum of technical requirements to production or meeting consumer's demands. A special place takes decorating-pattern color design of products for harmonization of decisions because it depends not only on characteristics of the applied material, creativity of the artist and the designer, but also possibility of application of various kinds of furnish of the knitted fabrics.

At the same time, the main tool of innovative development in technology of knitted manufacture is, first of all, creation of new structures of materials. And it is a question not of updating structures of knitting fabrics on the basis of existing processes and the equipment, but of creation of essentially new designs and consequence of new materials with new properties, and also technical decisions which initiate creation of new machines and mechanisms. On development of mechanical engineering it is possible to track those technological breaks which were born by an engineering technological idea. Updating of production also went on the basis of modernization of the process equipment.

There are enough facts to affirm that the majority of physical mechanical properties of knitted materials and products is defined by its structure and new structural properties. It concerns practically all objects of textile manufacture. The structure is base for creation of any production, processes and mechanisms for their realization.

Thus, ability to create new structures including knowledge in educational process matters for reproduction of an intellectual resource and the solution of practical problems. Main principles of the solution of such problems are concluded in methodology of structural synthesis and the system approach.

Historically many problems of structural synthesis were solved within the limits of inventive activity on the basis of experience, intuition and rational thinking. As a result, the attributes used for the characteristic of various objects (inventions) have been certain and necessary conditions of carrying out the information analysis of environment are certain to define a level of techniques and a reference point of the further development. However to perform such work presently it is rather uneasy.

It is possible to ascertain as the fact, that in a science, education (owing to information "explosion") and practical activities there was a dialectic contradiction and a crisis situation

between growth of quantity of the information and an opportunity of operative data processing in real time. Development of traditional verbal sources of knowledge even in a narrow subject domain represents a real problem "to keep up to science level". The solution of this contradiction lays in a sphere of the formalized description of technological knowledge, their structurization, compact representation and construction on this basis of effective systems of gathering, storage and transfer of the information, and also machining of data and information search. As a whole it is a question of creation of new information culture [2], [3].

It is also essential that creation of new innovative decisions lays in sphere of the new ideas, fundamental knowledge and structural synthesis. The world of engineering creativity, inventions, the copyright is not a result of numerical and mathematical calculations but search of the structural decisions concerning creation of new kinds of products.

Thus consider that the problem of any complexity can be reduced to a problem of search of decisions in discrete space of conditions (alternatives), if it is formalized in terms of an initial condition (S_0), final (S_e) and formulas (F) (rules) of transition in space of events [4]. Formalization of representation of objects is a basis of creation of databases and knowledge bases when transiting to algorithmization and computer processing, including expert systems.

The most universal form of data presentation (and "knowledge, skills are data and rules of work with them" (Dijkstra)), reflecting the law of the form of various objects and their properties, the matrix of data is. The matrix cell of data, its coding (figures, signs, color, an image and etc) gives the most informative meaning of essence of discrete object, deepening processes of perception of knowledge and efficiency of thinking.

The matrixes' theory of data leads to uniform technology of the analysis and structural synthesis (as attitudes of variables), reflects psychological aspects of creativity, connected with purchase, structurization and processing of the information, figurative representation of object [5].

In textile technology, in particular in knitted manufacture, matrix and sign forms of display structure materials traditionally remained the basic compact and clear forms of technological knowledge. In fact, all textile objects have discrete structure, including fibers, yarn (threads), knitted cloths and products. Processes of their manufacture are also discrete. Therefore models of such systems can be considered as algebraic at a design stage, and processes as complex (time) event systems [6], [7], connected with change of states of "processed objects".

The problem of creation of new structures and expert systems ("soft algorithms") [7], [8] being based on the theory of discrete mathematics should be constructed not on an intuitive basis (in the certain sense as unsystematic primitive search and "blind" search of variants which leads to deadlock decisions, when the top of "a tree of decisions" appears trailing [7]), and as a problem of a logic conclusion of new attitudes of structural elements of initial base set with use of the certain generating rules and technological knowledge.

It is known, that any object of discrete system should be presented only by one essence which should be is unique identified. The name of essence should reflect a category, type or a class (concept) of object, instead of its concrete copy. Generation of new objects is dependent essence or new concept [9]. Presence of unequivocal identifiers of concepts allows to form the dictionary of base elements of a subject domain, to use computer processing knowledge (in particular to pass from structure fabric to technology of their manufacturing and creation of new technological machines). Identification of production in the market of sales is a basis of recognition of properties of materials, decrease in risks of losses and safety of production.

It is possible to consider that some set of M with the set of attitudes R can be a model of discrete system (object), i.e. a design of a kind $\psi = \langle M, R \rangle$ [8].

For knitted structure fabrics it is possible to generate base set E of structural elements from known $\{e_i\} \in E$ supposing that all these

elements form orthogonal space of attributes[1], and have the certain length (i.e. are parametrically set) and can be certain at the analysis in a numerical kind. To this set the following can be carried: known loops of a various kind – plain loops (face, back), rib loops (face, back), terry, tuck and futter loops; floats, including weft threads, jacquard and etc.

Let's use a matrix method of formation (synthesis) of interlacings (structure of jersey) on model $\psi = \langle M, R \rangle$ in the form of the bidimentional table, each line (column) of which we shall biuniquely compare to elements of set of M. Set of M we shall consider as some final set E of base elements of structure of jersey, i.e. we shall put $M = E = \{e_u \,|\, u = 1, 2, \ldots, U\}$, where U – some number of elements (units) which with a high probability can be used at formation of structures of knitted interlacings and fabrics and can extend. At the task of binary attitudes in the form of a matrix which fragment is presented on Fig. 2 each line (column) we shall compare biuniquely to element of set of E. Therefore each cell (i, j) matrixes (which can be realized technologically) can be presented in the form of logic crossing elements $e_i \cap e_j \,(e_i e_j)$ corresponding to the binary attitude $R_e^{(s=2)}$. Theoretical capacity of such set $E \times E = E^2$. I.e. the binary attitude $R_e^{(s)}$ on set E is the subset of its square: $R \subset E^2$. In this case the matrix E^2 will represent attitudes at display of set to, and its attitudes to represent set of the ordered pairs $(e_i e_j)$ or trains of two-componental interlacings, such that $\{e_i\ e_j\} \in E^2$.

In a matrix of base elements E on which algebraic binary operation is certain, we shall add an individual element e_0 [7], such that $å_0 \cdot e_i = å_i$, $å_0 \cdot e_j = å_j$ which gives identical (monadic) display of elements (often designate at additive record in zero). It allows to form unicomponent (one threads) structures of interlacings in coordinates of knitting field (in each point to add on one element), and also attitudes any "measure size", both even and odd. In view of it, theoretical capacity of set of binary attitudes increases up to values $M = E^2 + E$, and capacity of all decisions is practically unlimited.

In each point of coordinates (crossing loop course and wale) fields of knitting $k = \langle k_w, k_c \rangle$[2] in a direction of axes w and c within the limits of chosen rapport R_B and R_H interlacings $k_w = \{1, 2, \ldots, R_B\}$ also $k_c = \{1, 2, \ldots, R_H\}$ can be formed unary, binary, including n-ary attitudes of elements, i.e. individual, double, threefold, etc. sets or groups $R_e^{(s)}$ are formed at transition from one coordinate to another. As result, within the limits of the chosen size coordinates we have set M_S of interlacings in the form of associations $R_e^{(s)}$ of elements in structural complexes - cells SKC (Structural Knitted Cell)[3] of the interlacings belonging to certain properties R_e^*, i.e. $R_e^{(s)} \subset R_e^*$ of which elements are formed.

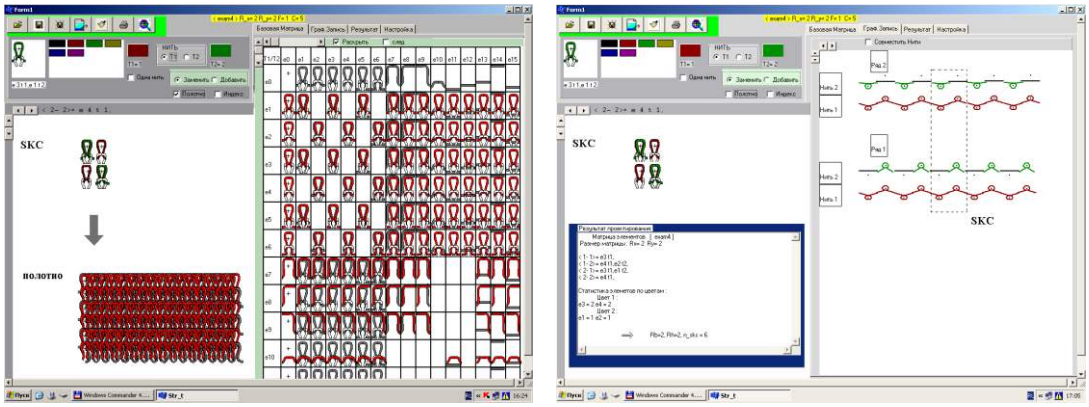
The methodology of synthesis of interlacings of regular structures on a matrix of binary attitudes has been realized in the form of the computer version (Fig. 1) at work in a mode of expert system. The program allows to carry out "assembly" of structural elements in complexes (cells) SKC, to realize visualization of the fabric (Fig. 1) and to display results of synthesis in the form of formalization of structure and a semantic design of an interlacing (Fig. 1). The result of designing is: the size repeat interlacings R_B and R_H, quantity and a kind of applied threads t_h[4], graphic record of an interlacing and quantity of elements n in structural cell SKC of a cloth.

[1] Orthogonality of space means that change of any component does not entail automatic change of another.

[2] Abbreviation *w* and *c* from English *wale* – a loop column, *course* – a loop number.

[3] The concept of a structural cell (unlike раппорта) is a basis of the description and designing of properties of jersey and is base concept of a structure of jersey of a foreign science and an expert. For the first time has entered J.J. Knapton.

[4] From English *thread* – the yarn.



a) b)

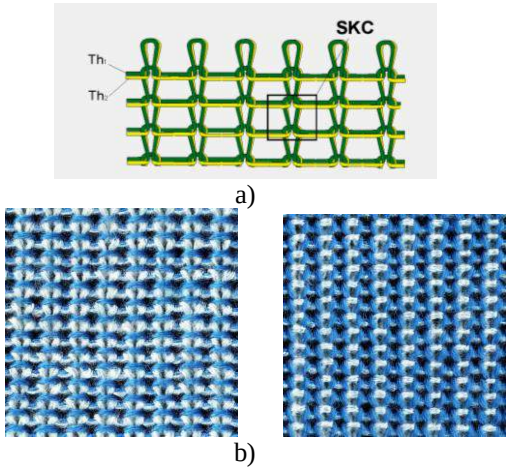
Fig. 1

The final decision as information model can be presented in the form of the formalized semantic design (train) of defining attributes

$$\langle \text{interlacing } m_S \in M_S \rangle ::= \langle \text{name of elements, } e_i \in E \rangle \langle \text{type of thread, } t_h \in T_H \rangle$$
$$\left\langle \text{type and size of logical attitudes, } R_e^{(s)} \right\rangle \left\langle \text{coordinates } K_w \in R_B, K_c \in R_H \right\rangle,$$

which uniquely identify an interlacing[5], including creation of databases in the software.

The received data, firstly, is enough for designing technological process of knitting of the fabrics and drawing up of operating technological programs of the automatic knitting machines, secondly, for the solution of problems of parametrical synthesis of the developed interlacings.



a)

b)

Fig. 2. Structure of a new interlacing (*a*) and a general view of samples of the face and the back sides (*b*) m_s = $<T_{h1}e_1; T_{h2}e_2>$. The variant 1

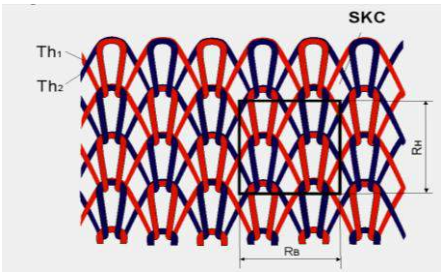
Except for the description of interlacings matrix M_S works as the tool of synthesis of new interlacings by consecutive search of decisions on the basis of "crossings and summation of cells" matrixes. As an example, on Fig. 2, 3 unknown to us before are shown interlacings: crossing in one coordinate face and back loops[6] (Fig. 2) – a variant 1 or crossing in each of coordinates of a loop and a tuck stitch, formed from various yarns (Fig. 3) – a variant 2. Experiment shows, that such interlacings (Fig. 2, 3) possess new structural properties, and their realization underlies creation of new processes and functional mechanisms of knitted machines, i.e. initiates development of new technologies and creation of knitted materials with new structural and physic mechanical properties.

The developed tool of computer design (synthesis) transforms a problem of creation of new interlacings into simple engineering procedure, raises efficiency of innovative works, meets new requirements of construction of educational process, perception and processing of the information at higher (cognitive) levels, promotes development of productive creative thinking.

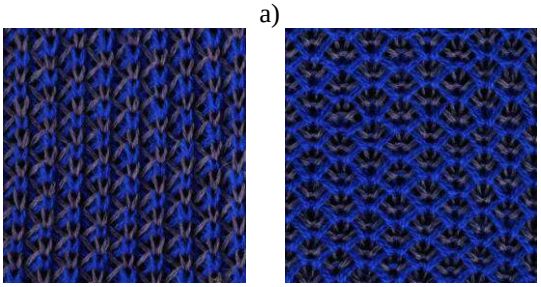
Our position is that the productive creative component of activity should be based on synthesis of new objects, as opposed to the concept search of decisions on the basis of the analysis of opportunities of existing technological processes and textile machines.

[5] Regular structures without transformation of structural elements mean. Their synthesis demands construction of an additional matrix of binary attitudes.

[6] Authors recognize the level of incompetence if such interlacings are known.



a)



b)

Fig. 3. Structure of a new interlacing (a) and a general view of samples of the face and the back sides (b) $m_s = <T_{h1}e_1 \cap T_{h2}e_7 \cup T_{h1}e_7 \cap T_{h2}e_1>$. The variant 2

Synthesis of new textile designs allows to create new processes and the new process equipment, initiating development of textile technology and mechanical engineering.

Analyzing the developed methodology of structural synthesis of interlacings we come logically to creation of knitted machines of the future as the robot systems simulating manual knitting. Such machine should be equipped by an individual independent drive loop knitting parts and yarn finger and forming programs of knitting process on base synthesis of new structure fabrics. It is already possible to find in the world practice realization of such constructive decisions (f. Shima Seiki (Japan), f. Karl Mayer (Germany), etc.).

B I B L I O G R A F Y

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