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The collective monograph contains the results of the synthesis of theoretical materials, as well as the authors` applied research developments on the design of the clothes of different assortment and purpose, made from different materials considering the modern scientific methods.

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CONTENT

2.5. CHILDREN'S SPORT CLOTHES DESIGN: METHODS AND COMPOSITIONAL MEANS

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Abstract. *The work is devoted to improving the process of designing competitive and ergonomic children's clothing for roller skaters. The introduction of modern ergonomic design tools into the process of industrial design has been proposed. On the example of developing children's clothing for roller skaters the mechanisms of realization of such stages of designing as "design research" and "design concept" have been considered, where the requirements for designing have been developed, the main ideas for solving the set tasks have been formulated and the basic principles of product construction have been formulated. They are about creating clothes with advanced functionality with the use of transforming and damping elements.*

The method of experimental determination of the parametric characteristics of the protective elements and their locations on the construction details have been described, as well as the choice of a rational structural device in accordance with the study results of the dynamic conformity of children's clothing design for roller skaters. The rational constructive-technological and color-graphic models of multifunctional children's costume of roller skaters have been presented and the model range has been created on their basis.

Keywords: *multifunctional children's clothing, clothing for roller skaters, safety elements, design research, design concept, model range, transformation methods, transformative clothing elements.*

Introduction. Technological progress, lifestyle changes, environmental changes, development and spreading of new activities – factors that transform the everyday concept of everyday clothes into the classical sounding. Nowadays, everyday clothes are not just a set of products designed to be worn in various household and social conditions, but, above all, a complex design object. It performs not only the main functions: protective, informational, aesthetic, but also satisfies the hidden needs of consumers due to the peculiarities of modern human life.

Statement of the problem. A fairly large group of clothing consumers are children, whose lifestyle has its own characteristics in accordance with the age of psychophysiological development. Since the age of 3-4, children learn to adapt to any circumstances, adapt to any environment and master new types of physical activities, such as cycling, scootering, skateboarding, rollerblading, etc., and therefore risks of injuries of varying degrees increase. In such situations, everyday clothes are not able to fully protect the child's body from damage, especially in summer, when a set of clothes consists of a minimum number of things.

It is known that in order to protect the human body from mechanical and impact loading in various sports we use special clothing and personal protective equipment (PPE). Specialists and scientists have long been engaged in the development of protective clothing of various functional orientations. The main principles and approaches to the design of varieties of protective clothing are set out in the works of Chubarova Z.S., Kolosnichenko M.V., Ostapenko N.V., Tretyakova L.D. and others [1-7] However, these provisions relate to the ergonomic design of special clothing, the use of which is expected in certain harmful conditions of the production environment. But it should be noted that such clothing has a specialized purpose and its use in household conditions is not expected. Therefore, the creation of everyday clothes with additional protective capabilities is an urgent issue for nowadays.

Results of the research and their discussion. Multi-functionality as a direction was chosen to create children's clothing for roller skaters, which allowed to develop a concept based on the ideas of versatility, interdimensional transformation, high ergonomics and resource efficiency of production. For its implementation and adaptation to the production process, an improved method of industrial design has been used, the main differences of which are the presence of stages of design research and design concept (Fig. 1).

The application of design thinking approaches to modern clothing design has revealed the so-called “hidden needs” of the consumer, which he himself is unable to realize and verbalize. For this purpose, design studies are conducted to identify, interpret and visualize information in a form accessible for further communication to all parties involved in the process [8-12].

One of the technologies created on the principles of design thinking is ergonomic design. It is presented as a new type of design activity, different from the traditional ergonomic and artistic design. The purpose of ergonomic design, in the broadest sense, is to ensure the success and well-being of a person in many areas of his activity. This is achieved by ensuring the unity of the three aspects of design —convenience, comfort and aesthetic perfection of the means and conditions of human activity. The mechanism of the phenomenon of “ergodesign” is expressed in integrating design and ergonomics. Thus, in the works of Kolosnichenko M.V., Ostapenko N.V., Pashkevich K.L., Baranova T.M., Tretyakova L.D., Smirnova M.R., Kolosnichenko O.V., Nikolaeva T.I. etc. [8-14] the problem of obtaining competitive garments for various purposes from the standpoint of an integrated approach have been solved as well as the principles of transformation and scientifically sound parameterization.

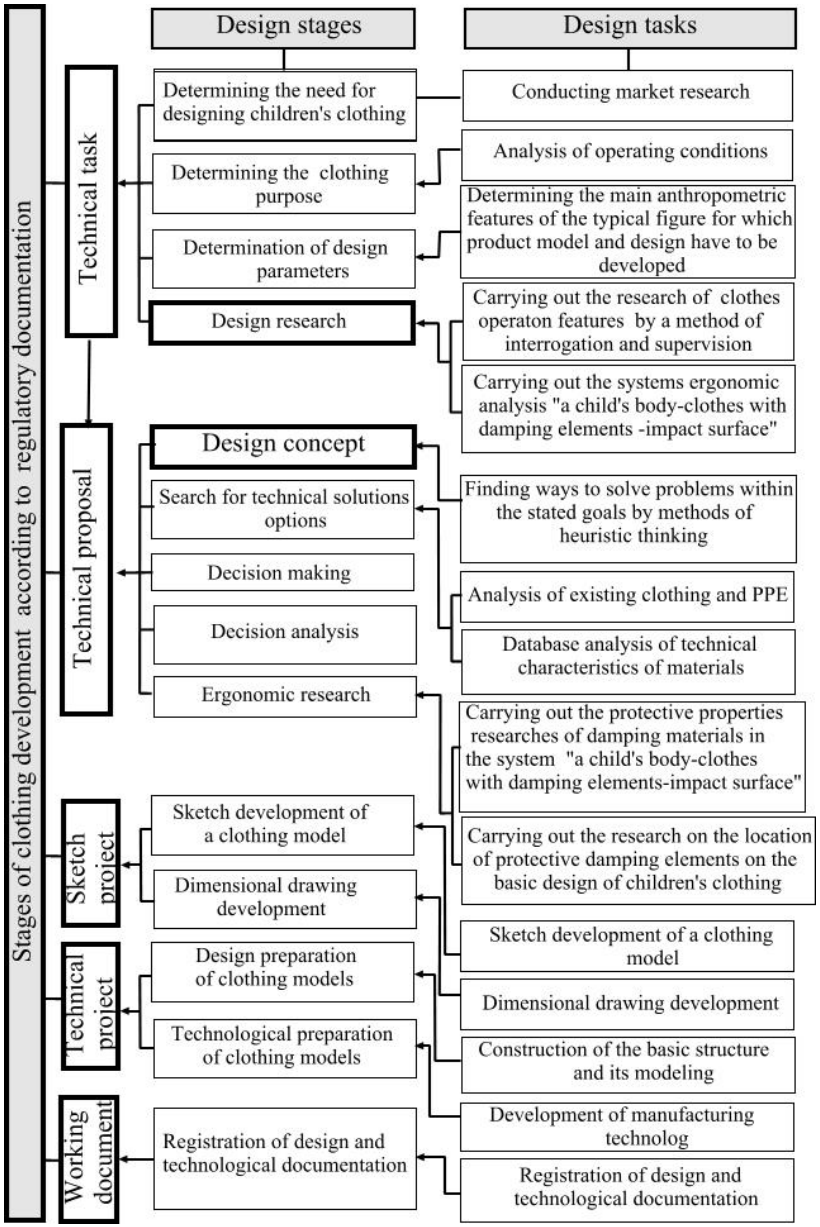


Fig. 1. Improved structural scheme of the designing process of children's clothing for roller skaters

However, in these works, the improvement of functionality is considered from the standpoint of designing special clothing, and the design of children's clothing was addressed in terms of anthropometric and ergonomic parameterization of the construction drawings of products.

Experts consider that a modern scientific approach to the design of industrial products and the subject environment is inconceivable without the use of ergonomics. That is why the main thesis of one of the works of recent years, the authors of which are V.M. Munipov and V.P. Zinchenko, says: “Any design work cannot be carried out outside of the connection with ergonomics” [15].

This view is complemented by the fact that the quality of products in the XXI century, which a number of international organizations has declared a century of quality, cannot be achieved without taking into account the requirements of man to the products. In this regard, any design for humans should involve the implementation of a wide range of knowledge about the human factor. The purpose of the “design research” stage was to identify the operation features of children's clothing used for roller skating. Using the observation and survey method, it has been found out that children begin to learn roller skating usually during walks in the fresh air and in specialized roller rinks. However, the time spent on rollers in the initial stages of training is 15-20 minutes, due to the unusual load on a certain muscle group and their rapid fatigue. That is why there are long breaks between workouts during one walk, and that is why household clothes are the ones that are most often used in this situation.

The use features of such clothing in accordance with the described situation leads to the need to analyze the child’s movements while learning to skate. It should be noted that roller skating classes include exercises to warm up the muscles without the use of rollers and PPE. Such exercises include warm-ups for different parts of the body: chest, back, arms and legs. The child's movements analysis allowed to develop sportswear with high dynamic compliance for use not only during roller skating training, but also during walks.

The result of the “design research” stage is the requirements development for the design of children’s clothing for roller skaters. Given the above information, it has been determined that children's clothing should: be comfortable to put on and take off; provide an adequate degree of protection against all types of danger; have damping properties sufficient to protect the parts of the body affected; protect the thighs and forearms from injuries of varying degrees; have such a design and ergonomics to ensure the highest possible level of consumer protection, and the consumer to be able to perform risk-free activities without complications; have pockets for carrying personal belongings that would be protected in case of a fall; be as light as possible, but at the same time provide the necessary strength and effectiveness of protection; set the maximum

possible levels and classes of protection; the optimal level of protection that must be taken into account when designing – the maximum level of protection at which the effectiveness of clothing is not reduced during exposure to risk factors; to ensure harmlessness, i.e. not to create additional risk factors and other harmful factors, and the absence of risk factors and other "internal" harmful factors when used in the intended conditions; be made of materials that do not adversely affect the consumer's health, and the decomposition products of the materials should not adversely affect the consumer's health; have the surfaces nature of clothing components that touch or are potentially capable of touching the consumer, so as not to cause skin irritation or injury, i.e. should be smooth, not have sharp edges, protruding parts, etc.; have the maximum allowable restriction of movements; to provide fast finding of the child in the conditions of limited visibility; to correspond to the trend and to provide good aesthetic perception; have the means to adapt to the morphological characteristics of the consumer, such as adjustment or fastening systems, or be available in several versions of different sizes; ensure the possibility of proper fit on the consumer's body and remain in the correct position throughout the time of use, regardless of environmental conditions, movements and position of the consumer; have the strength of the clothing material and the joints so that when the clothing engages with a moving object, it is torn or broken, ensuring the consumer's safety; have appropriate markings on the size of clothing; to have a comfortable microclimate of the clothing space during training and relaxing; be made of material resistant to mechanical deformation; be multifunctional (used as sports and casual wear) [16].

The developed requirements allow to pass to the next stage of designing (Fig. 1) – "design concept" creation. The purpose of the design concept is to find ways to solve problems within the outlined requirements. During this stage, based on the pre-project analysis, key conceptual ideas (possible variants of ideas) are developed, which allow to determine the further course of the project [17,18]. In order to identify and propose the main ideas for the implementation of the tasks, it is necessary to identify key factors influencing the future concept. Such key factors for children's clothing for roller skaters are its use throughout the walk with the child and during the process of learning to skate; protection of the body areas that are damaged and not protected by PPE; convenience in selection of the clothes size according to individual anthropometric parameters of children aged 4-5 years.

Given the above, at the "design concept" stage the idea of expanding the functionality and consumer qualities of sportswear by applying the principles of transformation and modern damping materials was proposed.

At the stage of searching for technical solutions, an analysis of the range of modern sportswear used to protect against shock loads was

conducted, which revealed that its variety is quite large, and the use of protective elements in clothing is a fairly common design solution.

Protective elements in such types of clothing, as a rule, have a multi-layer structure and are made of the main fabric and tabs of foamed synthetic materials, which are connected to the details of clothing by welding, adhesive and thread connection methods (non-collapsible design) or by means of pockets of various types and forms (collapsible design). Damping materials, which are the basis of damping elements in clothing, are mostly made and developed by the manufacturers of such clothing. It is also known that the German company SEDO specializes in the production of its own know-how, foamed chloroprene rubber, best known under the trade name “neoprene” and is the only manufacturer of this material in Europe [19]. Among the range of materials they make are those recommended for making special clothing.

According to the results of the materials analysis used as protective damping gaskets of protective elements in special and sportswear clothing, it has been established that they are mostly made of elastic cellular polymeric materials. The latter have high elastic, damping and flexible properties. It is known that such materials differ in raw material composition; technology of obtaining a molecular model; cell structure; density, etc. [20, 21]. For their manufacture such substances are used as: polyethylene, polyurethane, synthetic rubber, etc., and to obtain a cellular structure, they use the method of foaming, whence the names “foamed polymers”, “foampolymers”, “cell plastics”, “foamplastics”, “polymer foams” and “sponge plastics”.

The analysis of the range of modern special equipment with damping elements allowed to develop a classification distribution of such elements according to the constructive device and transformation principles (Fig. 2).
To determine the location areas of protective elements on the details of multifunctional children's clothing, an analysis of the protection degree of the child's body areas that are injured by a fall has been performed, and a visual information and sign model has been developed (Fig. 3).

To obtain a rational design of multifunctional children's clothing, which takes into account all ergonomic requirements, the location of anthropometric points on the child's body has been determined, which take the shock loads when falling. To do this, a method which consists of direct contact of the model of clothing on the child's body with the surface, which creates shock loads during roller skating training, has been used. The topography of the distribution of contact areas on the details of the basic design of children's clothing (Fig. 4) allowed to obtain the dimensional characteristics of the protective elements, which are shown in table 1.

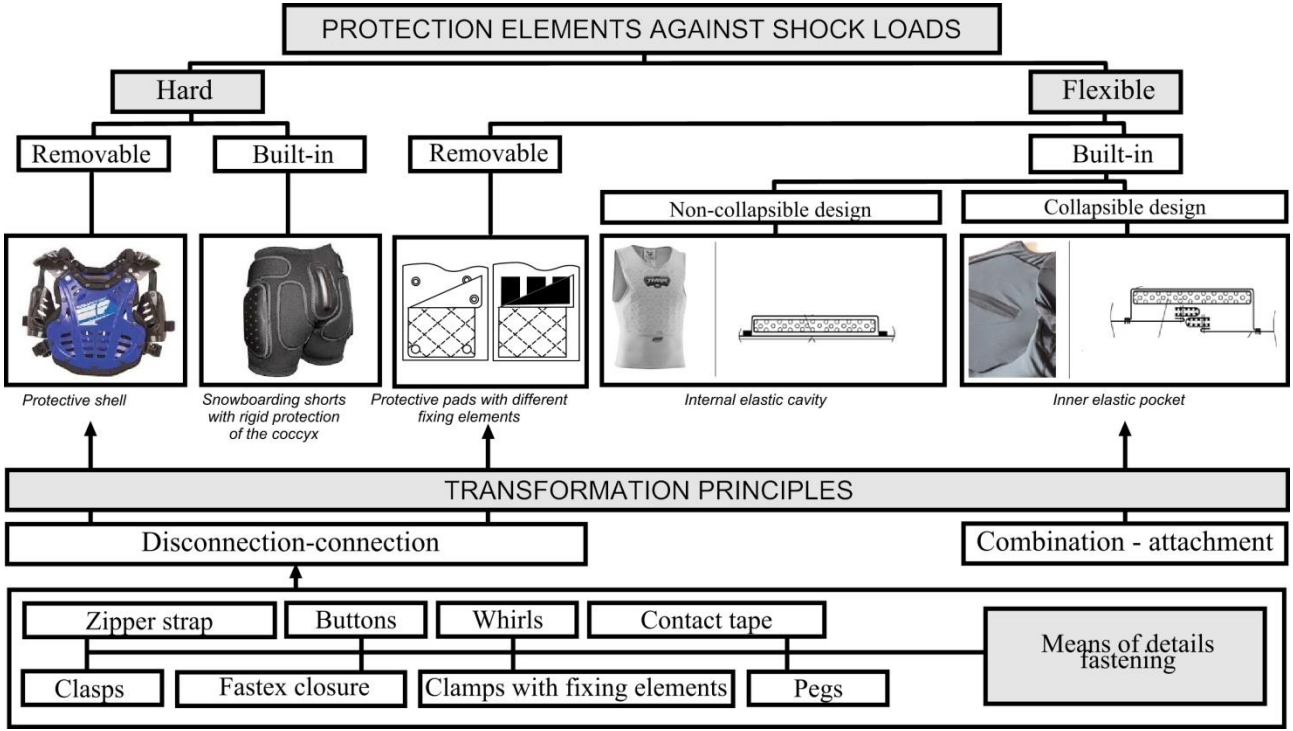


Fig. 2. Classification of protection elements from shock loads in sportswear

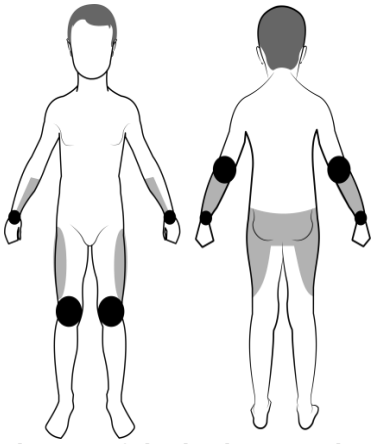
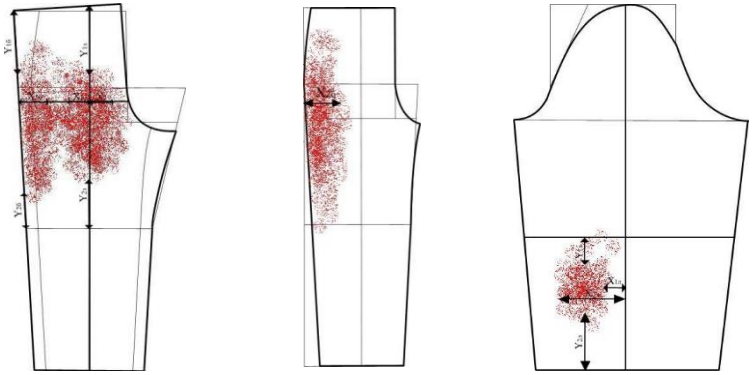


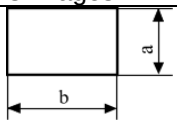
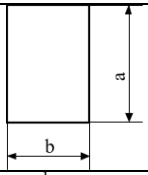
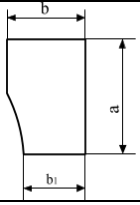
Fig. 3. The protection degree of the body parts that are most often injured (a – front view; b – back view):
- body parts protected by PPE,
- body parts having no special protection

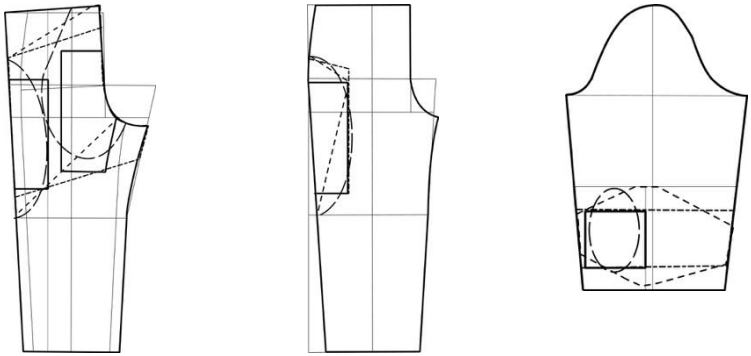


a) *b)* *c)*

Fig. 4. Topography of the distribution of contact areas on the details of the basic design of children's clothing:
a – trousers back half; b – trousers front half; c – sleeve

Table 1 – Dimensional characteristics of the protective elements of children's clothing

Details names	Details sizes	Details images
Elbow sleeve protective element	a=6,0 b=6,5	
Trousers side protective element	a=14,0 b=9,0	
Trousers back protective element	a=15,0 b=8,0 b_1=6,0	



a) *b)* *c)*

Fig. 5. The main modified design of children's clothing for roller skaters with protective elements and modeling of modification models:

a – trousers back half; b – trousers front half; c – sleeve

According to the study results, the information has been obtained, which made it possible to develop a sequence of modification of the basic design of children's clothing taking into account ergonomic requirements (location and optimal size of protective elements). The developed design is

shown in Figure 5 by a solid line. Using the developed modified design of children's clothes for roller skaters by constructive modeling (Fig. 5) a model range of products with various forms and types of protective elements (Fig. 6) has been received [22].

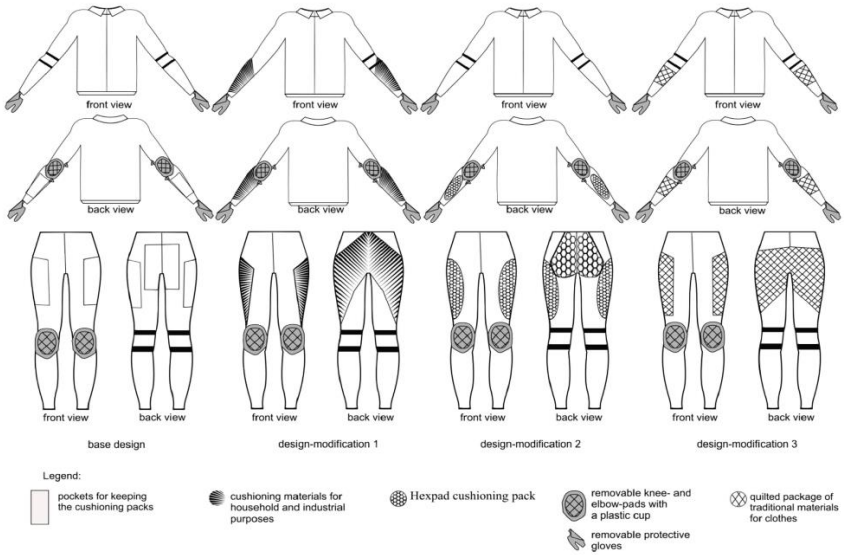


Fig. 6. Model range sketches of children's clothes for roller skaters with various forms and types of protective elements

To ensure the established requirements during the design, the principles of transformation to clothing elements have been applied, which are divided into two groups: those that can provide interdimensional adaptation (Fig. 7) and those that can hold damping materials that should protect the child's body from impact due to falling (Fig. 8).

The choice of rational design of transformative elements of children's clothing for roller skaters has been made by the method of expert evaluation.

Taking into account the results of research, a multifunctional children's suit has been designed, which was researched for dynamic compliance using an ergonomic stand.

The conducted studies have shown that the best dynamic fit is provided by a raglan sleeve with a gusset made of elastic material and a three-dimensional shape of the sleeve in the elbow area, formed by folds on the front seam; trousers with a yoke made of elastic material and three-dimensional shape of the trousers in the knee area due to the folds on the side and step seams.

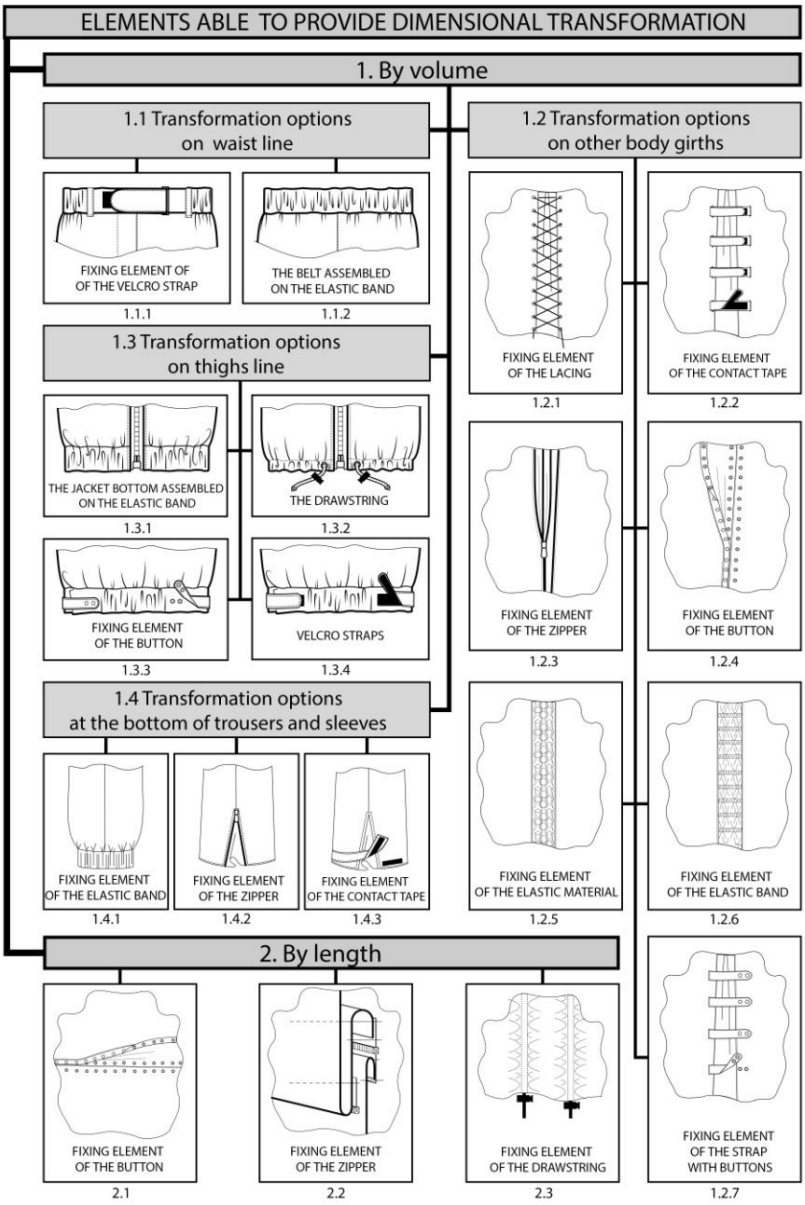


Fig. 7. Matrix of transformative elements that provide interdimensional clothing adaptation

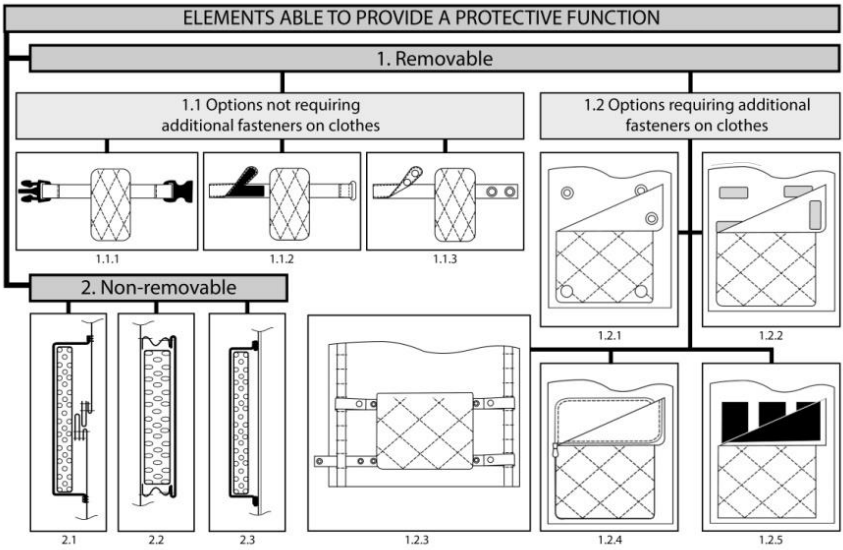


Fig. 8. Matrix of transforming elements that provide a protective function of clothing: 1.1.1 – fixing element of the clamp on the fastex closure; 1.1.2 – fixing element of the clamp on the button closure; 1.1.3 – fixing element of the clamp on the contact tape; 1.2.1 – fixing element of the button; 1.2.2 – fixing element of magnetic buttons; 1.2.3 – fixing element of the clamp with button closure attached to the periodically sewn tape; 1.2.4 – fixing element of the zipper; 1.2.5 – fixing element of the contact tape; 2.1 – fixing element of the inner pocket; 2.2 – fixing element of the patch volume pocket; 2.3 – fixing element of the three-dimensional elastic cavity.

An important factor that affects the consumer demand for garments is also the appearance of the material from which they are made (texture, color scheme, luster, compliance with trends, etc.). The product, as a unit of goods, is evaluated by the consumer when comparing it with the ideal, i.e. a person's idea of beauty, which is formed under the influence of such factors as living standards, climate, national and individual characteristics, etc.

It is known that the colour of clothing for most consumers, as an aesthetic indicator prevails over other groups of quality indicators and affects the emotional and sensory experiences [23].

Peculiarities of psychophysical development of preschool children determine their desire to identify themselves with significant people or film characters, cartoons, etc. And because modern children are constantly under the influence of modern multimedia, they easily create an image in the imagination, which is then imitated in real life, transferring its special

characteristics to their behavior, clothing and games. Obviously, the most successful form of meeting the requirements of age psycho-emotional characteristics of preschool children can be a holistic image-composition solution of children's clothing developed on the basis of associations with cartoon and game images [24]. As a research material, popular multi-series cartoons have been selected, the characters of which, according to the concept developed in the work, have the ability to transform.

The list of cartoons with characters-transformers, which are most often viewed by children of primary school age, has been obtained as a result of parents' survey. The most popular cartoons are listed in Table 2 with the main colour scheme of the main characters' images.

Table 2 – Colour characteristics of the images of the cartoons main characters

Colours / Cartoons	black	white	yellow	orange	red	dark blue	green	violet	brown	pink	light blue	turquoise
«Robocar Poly»		+		+	+	+	+					
«Heroes in masks»	+				+	+	+					
«The Fixies»			+	+	+	+	+	+	+	+	+	
«The Transformers»	+	+	+	+	+	+	+					+
Total	2	2	2	3	4	4	4	1		1	1	1

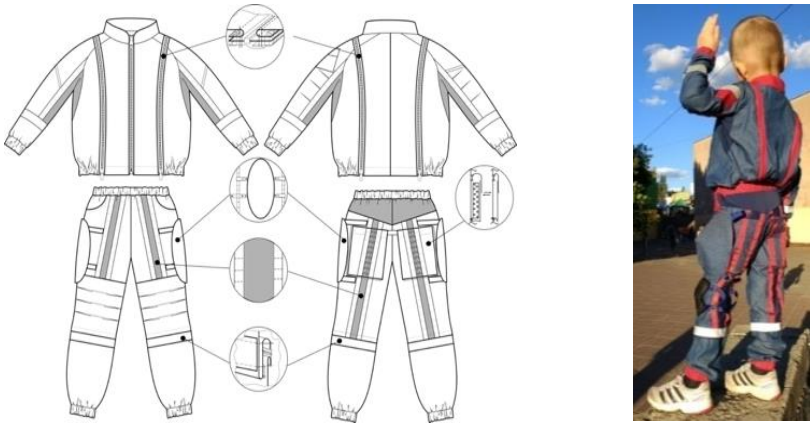


Fig. 8. Design-technological and layout-colour solutions of children's multifunctional suit for roller skaters

As a result of the research the actual colour scale of children's multifunctional suit for roller skaters has been determined, namely the combination of the basic colours of blue and red with finishing inserts of dark blue and bright red colors. Based on the research, an artistic and design solution of the basic model of a children's multifunctional suit for roller skaters has been developed (Fig. 8) [25].

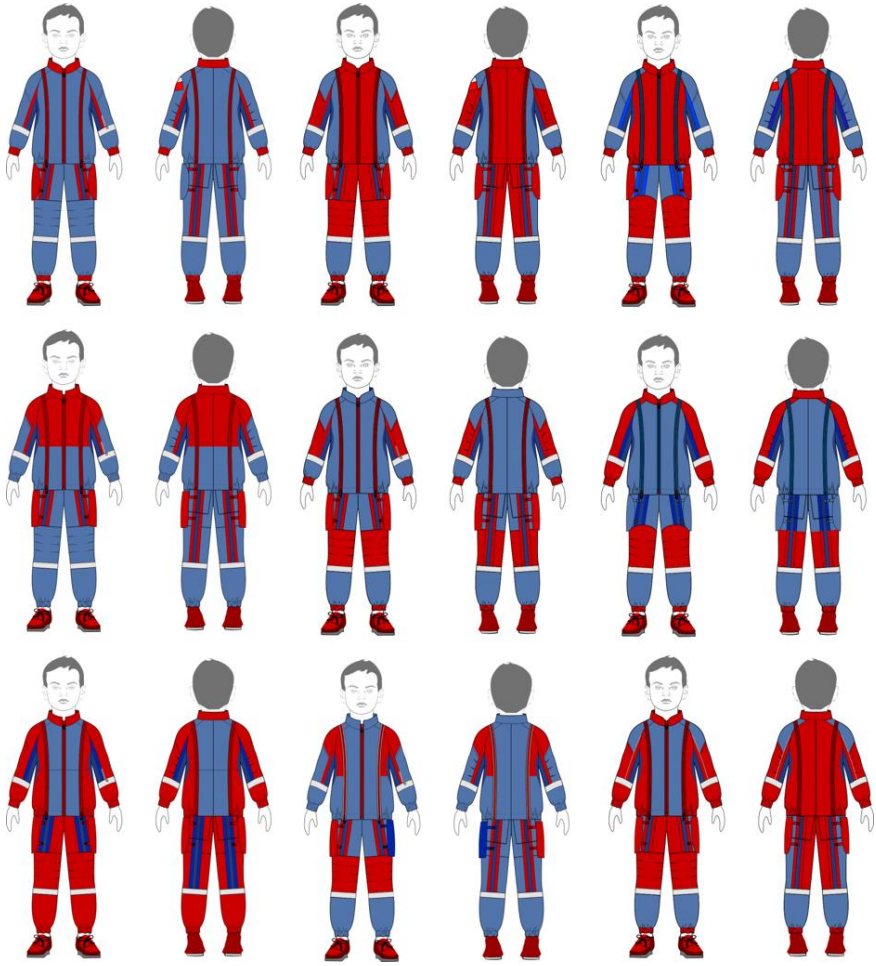


Fig. 9. Models product line of children's multifunctional suit for roller skaters

The suit consists of a jacket, trousers up to the middle of the calf, the removable lower parts of the trousers, protective elements: pads, elbow pads; knee pads and shock absorbers. On the basis of the basic model various stylistic layout and colorr solutions of sets of children's clothes for roller skaters have been developed (Fig. 9).

Conclusions. As a result of the conducted research the scientific and technical task of expansion of functional possibilities of modern competitive children's clothes for roller skaters has been solved; regularities of construction of clothes with damping elements and parametric characteristics of protective elements and their location on a typical basic design of children's clothes for typical figures have been researched; the process of designing competitive children's clothing for roller skaters through the use of modern design tools has been improved; a comprehensive approach to the creation of multifunctional clothing has been proposed, according to which the choice of design and technological solutions to ensure interdimensional transformation has been substantiated. An artistic and design solution of a multifunctional children's suit for roller skaters has been developed, the novelty of which has been confirmed by the patent of Ukraine for an industrial design, as well as a range of children's clothing for rollerskating with justification of their layout and colour solutions.

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