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Issue Article

Artur Alexandrovich Blagorodov
Institute of Service and Entrepreneurship (branch) DSTU
master, Shakhty, Russia

Maxim Romanovich Ermuraki
Don State Technical University
Master

Grigory Alexandrovich Zemsky
Don State Technical University
Master

Olesya Anatolyevna Golubeva
Don State Technical University
candidate of technical sciences, associate professor,
Rostov-on-Don, Russia

Galina Yurievna Volkova
LLC TsPOSN «Orthomoda»
Doctor of Economics, Professor
Moscow, Russia

METHODOLOGICAL BASES FOR THE FORMATION OF A REHABILITATION CENTER FOR CHILDREN WITH PATHOLOGICAL ABNORMALITIES. MESSAGE 2

***Abstract**: In the article, the authors consider the role of quality as a tool for promoting the philosophy of quality in the production of competitive and in-demand products at light industry enterprises located in the regions of the Southern Federal District and the North Caucasus Federal District. At the same time, the authors absolutely reasonably confirm the possibility of such an implementation if innovative centers are implemented, saturated with universal and multifunctional equipment, creating prerequisites for the production of the entire range of footwear, namely: men's, women's and, most importantly, children's shoes, the demand for which in regions of the Southern Federal District and the North Caucasus Federal District is quite high. And the use of software will provoke a significant reduction in the cost of its production and provide it with a steady demand in domestic markets with unstable demand, including for children with pathological abnormalities.*

***Key words**: quality, preference, demand, competitiveness, market, profit, demand, buyer, manufacturer, financial stability, sustainable TEP, priority, assortment policy, economic policy.*

***Language**: English*

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Introduction

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The developed designs of the shoe upper, paired with an anatomical instep support, will provide the most effective support for the arch of the foot and correction of the angle of its inclination. This ensures the correct development of the articular surfaces and eliminates the further development of deformation. The essence of the developed design of the insole is that it has an additional intermediate layer, which is a flexible surface covered with silica gel granules located above the elastic lining layer over the entire surface of the insole. The insole is a multi-layer structure consisting of an upper layer, an additional intermediate layer and a flexible material, the surface of which is covered with silica gel granules of various diameters in various areas, located above the intermediate elastic layer-liner over the entire surface of the insole and the bottom layer. In the sketches of children's shoes for the prevention of flat-valgus foot, models are developed on the basis of a single figurative solution, style, and material properties. At the first stage, it is proposed to develop 4 - 5 models of the product being designed in order to select the optimal design and color solution for the base model; when developing them, it is necessary to take into account the design of the block, the shape of the toe. The final decision on the choice of the base model is made after agreement (Table 1). At the same time, a comparative assessment of the model is carried out in terms of manufacturability, unification, and technical aesthetics. When developing sketches of leather products, one should approach from the main positions:

functional, predetermined by the purpose of products;

constructive (constructive-technological), reflecting the rational and economic use of the material;

aesthetic. Pad index 311251 Size-180

Table 1. Pad characteristic

Name of the classification feature	The established value of the classification feature
1. Gender and age group of pads	children's
2. Pad subgroup (heel height)	10 mm
3. Numbering system	metric
4. Initial block number	180
5. Completeness of the block	4
6. Pad type	For closed shoes
7. Shoe construction	articulated
8. Numbers of pads in the series	175 - 200
9. Number of obligatory completenesses, numbers of completenesses	3
10. Interval between adjacent widths by girth, mm	6
11. Pad index	311251

On the basis of the selected model, a sketch sheet is developed, where, along with the base model, another 4-5 models are placed, which differ from the base one in the presence of additional or modified parts, or accessories, fastener designs, soles, heels, etc. At the same time, the main details should not be changed, because. when cutting, it is necessary to keep the same cutter. You can change one or two details. In the text it is necessary to make references to the assigned model numbers of the unified series, indicating these numbers. Give a detailed description of all models of a unified series and their designs, distinctive features, the sketches must reflect the type of materials used. A unified series is created on the same basic base for shoes; for leather goods - two unified rows. When choosing materials for the details of the top and bottom of shoes, it is necessary to proceed from the type and type of shoes, their purpose, requirements for details, fashion trends. For all details of the top of the shoe (one pair), one type of material is usually used, only sometimes two types of material are combined. When using leather, some difference in the requirements for the details of the upper of the shoe is taken into account by the selection of its thickness, density and ductility. So, the most important part (the yoke) is cut out from the leather saddle, and the secondary part (tongue) is cut out from the floor areas, which are more viscous and have a smaller thickness. The toe part of the vamp is the most protruding part of the shoe, therefore, the material for this part is subject to increased aesthetic requirements: it must be resistant to cracking, abrasion, dirt, its surface should be easily cleaned of dirt. The materials for the vamp are subject to more stringent technological and consumer requirements than for other parts, since the vamp works in a more complex force field both in the manufacture of footwear and during its operation. It is in this zone that the greatest stretching of the shoe upper blank occurs during molding and the maximum multiple bending occurs when worn.

From the point of view of hygienic requirements, the material for the upper of the shoe must provide a normal microclimate inside the shoe space, i.e. be waterproof on the front side, heat-resistant, have low thermal conductivity, be vapor-permeable, hygroscopic, sweat-resistant, have high rates of moisture absorption and moisture return. Shoe upper material should not emit or release in minimal quantities substances that can cause diseases of the skin of the foot and other organs. According to GOST 26165-2004 "Children's shoes", chrome-tanned leather according to GOST 939-88 can be used on the outer details of the top. Leathers for shoe uppers are divided into two main groups: Leathers for uppers and linings of mainly lame tanning for casual shoes. A special subgroup is suede - leather of fat and formaldehyde-fat tanning; Leathers for the upper and lining of shoes are divided according to the types of raw materials from which they are made, the configuration and method of tanning, the method and nature of the finish. In addition, the skin is divided by area, thickness, and also depending on the quality into varieties. State standards provide for the following types of finishing of the front surface of leather: smooth leather with natural unpolished, with polished and polished front surface; leather with an embossed front surface; skin with a cut front surface; patent leathers and wrinkled leathers. smooth leathers with a natural unpolished, with a polished and polished front surface; leather with an embossed front surface; skin with a cut front surface; patent leathers and wrinkled leathers. smooth leathers with a natural unpolished, with a polished and polished front surface; leather with an embossed front surface; skin with a cut front surface; patent leathers and wrinkled leathers.

Skins are produced with the following types of front surface coating; casein, emulsion-casein, emulsion, nitroemulsion.

Depending on the type of raw material, chrome leathers are subdivided into calciner, outgrowth, half-skinner, cowhide, bullock, etc. Comparison of the main physical and mechanical characteristics of the three types of materials is given in Table 2.

Table 2. Comparison of materials in terms of physical and mechanical properties

No. p / p	The name of indicators	Unit measurements	The value of indicators according to GOST or TU		
			Chromium. yalovka	Chromium. semi-leather	Chromium. outgrowth
1	Tensile strength (average value from longitudinal and transverse samples)	kgf/mm2	21/18	21/19	26/23.5
2	Elongation under load 1kgf/mm2	%	18 – 30	18 – 30	15 – 25
3	Stress at the appearance of cracks in the front layer (average value)	kgf/mm2	17	18.5	21-15
4	Coating resistance to repeated bending	Bending not less than	1500	1500	1500
5	Skin thickness at standard point	mm	0.9 - 1.2	0.9 - 1.2	0.8 - 1.1
6	The content of substances washed out by organic solvents	%	3.8 - 8.8	3.8 - 8.8	3.8 - 8.8
7	Chromium oxide content	%	4.3	4.3	4.3
8	Moisture content not less than	%	10 – 16	10 – 16	10 – 16
9	Average skin area	dm2	240	195	75
10	Wetting	%	18	16	16
11	Breathability	cm3/s	60 - 80	60 - 80	50 - 75
12	Vapor permeability	%	49	40 - 65	40 - 65
13	Average weight of skins	kg	21	11	6.5

Based on the data in Table 2, it follows that when choosing the outer parts of the top of a chrome yoke, the cost of a set of shoe uppers will be the lowest, which has a significant impact on the cost of shoes as a whole. But for aesthetic reasons, a chrome outgrowth was chosen for the outer details of the top. When choosing materials, it is recommended to use more widely new materials that replace natural leather, guided by the requirements of GOST or TR for finished products.

Description of the appearance of the product

1. Kind of shoes: preschool.
2. Type of footwear: boots.
3. Shoe style: 311212.
4. Mounting method: Adhesive.
5. Upper material: chrome leather outgrowth.
6. Bottom material: porous rubber.
7. GOST for shoes: GOST 26165-04 "Children's shoes"
8. Blank construction: closed type boots with c/p velcro strap, leather piping, heel and heel details. As an artistic design, a combination of colors was used.(picture 1).

Figure 1. Children's shoes for the prevention of flat-valgus foot

Table 3. Model passport

No.	Name of parts	Quantity per couple	Material name	Part thickness	GOST for material
1	Soyuzka	2	chrome outgrowth	1.1 - 1.3	939-88
2	Berets	2	jeans fabric	1.1 - 1.3	19196-84
3	Backdrop	4	jeans fabric	1.1 - 1.3	19196-84
4	Upper back piece	2	chrome outgrowth	1.1 - 1.2	939-88
5	NPR	2	chrome outgrowth	1.1 - 1.2	939-88
6	CPR detail	2	chrome outgrowth	1.1 - 1.2	939-88
7	Back detail	2	chrome outgrowth	1.9 - 1.0	939-88
8	Vamp lining	2	Sheepskin lining	0.9 - 1.1	940-81
9	Beret lining	2	Sheepskin lining	0.9-1.1	940-81
10	CPR lining	2	Sheepskin lining	0.9 - 1.1	940-81
11	Rear shock absorber	2	Foam rubber	10	NTD
12	Vamp lining	2	Termobaz	+	THAT
13	Heel interlining	4	Termobaz	+	THAT
14	toe cap	2	Thermoplastic material for toe cap	1.1 - 1.5	TU 17-21-597-83
15	Backdrop	2	Thermoplastic	+	TU 17-24-84
16	Insole prophylactic	2	Lining leather sheepskin+waste PU	+1.8	19196-84
17	Soft heel pad	2	Foam rubber	+	BAT
18	Main insole	2	Leatherboard	2.3 - 2.4	9245-84
19	Bedding	2	Batting	+	BAT
20	Heel	2	foam rubber	20	12365-84
21	Sole	2	foam rubber	8 - 10	12365-84

Product appearance description:

Figure 2 Children's shoes for the prevention of flat-valgus foot with leather back

1. Kind of shoes: preschool.
2. Type of footwear: boots.
3. Shoe style: 311212.
4. Mounting method: adhesive.
5. Upper material: chrome leather outgrowth.
6. Bottom material: PVC.
7. GOST for shoes: GOST 26165-04 "Children's shoes".
8. The design of the workpiece: open-type boots, consists of a vamp detail of the vamp, ankle boots, ZNR, soft edging of the ankle boots and a black belt with a buckle.

A combination of colors, decorative seams and perforation on the vamp (Figure 2) were used as decoration.

Table 4. Model passport

No.	Name of parts	Quantity per couple	Material name	Thickness details	GOST for material
1	Soyuzka	2	chrome outgrowth	1.1 - 1.3	939-88
2	vamp detail	2	jeans fabric	1.1 - 1.3	19196-84
3	Berets	4	jeans fabric	1.1-1.3	19196-84
4	The upper part of the beret	2	chrome outgrowth	1.1 - 1.2	939-88
5	NPR	2	chrome outgrowth	1.1 - 1.2	939-88
6	ZNR	2	chrome outgrowth	1.1 - 1.2	939-88
7	Back detail	2	chrome outgrowth	1.9 - 1.0	939-88
8	Vamp lining	2	Sheepskin lining	0.9 - 1.1	940-81
9	Beret lining	2	Lining leather	0.9 - 1.1	940-81
10	CPR lining	2	lining leather sheepskin	0.9 - 1.1	940-81
11	Rear shock absorber	2	Foam rubber	10	NTD
14	toe cap	2	Thermoplastic material for toe cap	1.1 - 1.5	TU 17-21-597-83
15	Backdrop	2	Thermoplastic	+	TU17-24-84
16	Insole prophylactic	2	lining leather sheepskin+PU waste	+1.8	19196-84
17	Soft heel pad	2	Foam rubber	+	BAT
18	Main insole	2	Leatherboard	2.3 - 2.4	9245-84
19	Bedding	2	Batting	+	BAT
20	Sole	2	Rubber	8–10	12365-84

Walking is an automated motor act, carried out as a result of an extremely complex coordinated activity of the skeletal muscles of the trunk and lower extremities. Human walking consists of separate steps, which are a simple locomotor cycle, where two phases are distinguished: transfer and support. With cerebral palsy, the formation of all motor functions is delayed and impaired. At the same time, motor impairments can vary widely. When developing designs of orthopedic shoes with a high rehabilitation effect for children with cerebral palsy, it is important to take into account the specifics of static, locomotor functions and movement disorders. Human movements and the normal functioning of muscles in general are possible only with normal innervation. All nerves entering and passing through the muscles should not be damaged and have breaks. With flaccid paralysis or paresis, the tone of the affected muscles is sharply reduced, active movements are absent or weakened, and there are no tendon reflexes. Either hypotrophy (a decrease in the number of muscles capable of functioning normally) or atrophy (a complete lack of movement) of the muscles occurs, therefore, when walking in patients with flaccid paralysis or paresis of the lower extremities, wobbling in the joints is observed. For flaccid paralysis or paresis of the lower extremities, an equinus foot is characteristic (that is, the foot is in a state of plantar flexion or, in other words, a drooping foot). With this position of the foot, in order not to touch the supporting surface while walking, the patient has to strongly bend the leg at the hip and knee joints. tendon reflexes do not exist.

There are several types of walking: normal, with additional support and pathological, which can occur when mobility in the joints is impaired, muscle functions are lost or impaired, as well as when the mass-inertial characteristics of the lower extremities are impaired. It is customary to consider the biomechanical structure of walking, highlighting the following elements: the spatial structure of walking;

temporal structure of walking; kinematics of walking; walking dynamics; innervation structure of walking.

The main biomechanical features of walking were established: reduction of the duration of the transfer phase, flexion position of the lower extremities, limitation of movements in the joints, reduction and deformation of the curves of the components of the support reaction.

A detailed comparison of the kinematics of the joints during normal walking and with cerebral palsy is shown in Figure 3.

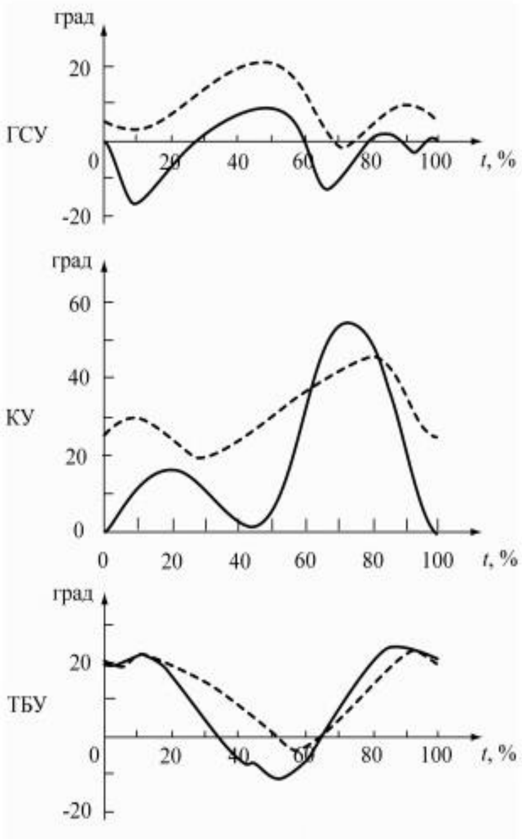


Figure 3. Graph of angular displacements in the joints of the lower extremities during normal walking (—) and patients with cerebral palsy (- - -): HCA – ankle angle; KU - knee angle; TBU - hip angle

From the graph of angular movements of the ankle angle (AGC) it can be seen that the first plantar flexion is reduced due to a short-term roll over the heel. Dorsal flexion in the support phase increases due to the preliminary tilt of the lower leg forward, the second plantar flexion decreases, which indicates insufficient repulsion of the foot from the support; dorsiflexion in the transfer phase has a small amplitude, which causes the possibility of touching the supporting surface with the toe.

From the analysis of angular displacements in the knee joint (KE), it can be concluded that the patient, without fully extending the leg in the joint, during the transfer phase, puts a half-bent limb on a support, then slightly unbends it, and as soon as the foot begins to roll over the anterior section, bends again. When analyzing the angular displacements in the hip joint (TBU), only a reduction in the extension angle is noted, while maintaining the main elements of the curve.

Studies of the phases of movement of the feet and the state of the ankle joint have shown that the time of support of the foot and the area of support are related to the design of the shoe. Thus, the biomechanics of the movements of children with such a disease determines the choice of a constructive and technological solution for the manufacture of shoes. So, in the case of maximum support on the toe part of the foot, the design of the shoe is performed with increased rigidity of the frame parts in the toe-beam part. With a longer phase of support on the heel - reinforce the frame parts in the heel-shank part. In this regard, in order to create designs of orthopedic shoes, it is important to analyze musculoskeletal disorders.

Musculoskeletal disorders in children with cerebral palsy are associated with developmental pathology or damage to the motor mechanisms of the central nervous system (CNS). The imbalance of the muscles of a child with cerebral palsy manifests itself in the inability to perform voluntary movements. At the same time, the acts of standing and walking, coordination of movements are violated. There is a predominance of flexor tone, adductor, penetrating muscles. Flexion (flexion-pronation) attitudes and contractures in the extremities, kyphoscoliosis, kyphosis, and scoliosis of the spinal column develop. With spastic phenomena, there is no phase of muscle relaxation, which leads to a slowdown in its growth and the development of a "short muscle syndrome", resulting in contractures. In the future, tissue hypotrophy develops and its replacement with connective tissue with a loss of contractility.

With cerebral palsy, there are violations of muscle tone, which plays a leading role in the reconfiguration of movements, their resistance, stability, and elasticity. There is a dysfunction of the "kinetic melody" of movement: from a smooth it turns into a jerky, disautomated, consisting of separate, unrelated elements. With post-central disorders of the cerebral cortex, afferent apraxia and insufficiency of cortical analysis of kinesthetic impulses are observed, which is expressed in difficulties in choosing the desired combination of movements.

The phenomena of underdevelopment include synkinesis: involuntary movements that are not related in meaning to voluntary movements. Table 3.10 shows data on movement disorders depending on the form of cerebral palsy.

The symptomatology of the disease may decrease somewhat against the background of ongoing conservative treatment (medicines, the use of botulinum toxin preparations, exercise therapy, etc.), but this is possible only at an early age (usually up to 5-6 years) and often to a small extent. In the future, in patients against the background of a persistent high muscle tone, their irreversible degeneration and shortening occurs, which leads to limitations in the range of motion in the joints (contractures), bone curvature, and the development of subluxations and dislocations.

Table 5. Movement disorders in cerebral palsy

Form of cerebral palsy	Movement disorders
Spastic diplegia	Impaired muscle function on both sides. Varies from severe paresis to mild awkwardness. Delay of rectifying reflexes of the trunk
double hemiplegia	Rigidity of the muscles always predominates, enhanced under the influence of tonic reflexes preserved over time.
hyperkinetic	Paralysis and paresis, manifested in the form of slow, viscous worm-like movements and convulsions with muscle contraction. Delayed reduction of tonic and adjusting reflexes. Muscular rigidity of the neck, trunk and legs. involuntary muscle movements
Atonic-astatic	Low muscle tone in the presence of pathological tonic reflexes. Absence or underdevelopment of installation reflexes. High tendon and periosteal reflex. Trunk ataxia. Impaired coordination of movements
Pemiparetic	Trophic disorders, slowing of bone growth. One side of the body is affected

The general functional activity of the patient in his usual environment can be assessed according to the Global Motor Function Classification System (GMFCS). It is important that it is the daily level of activity that is assessed, and not the maximum possible, demonstrated only during the study. The scale is divided into 5 levels, each of which has different motor abilities and different age periods. The scale establishes the child's ability to move, including with the use of assistive technologies. The levels of motor functions according to the GMFCS scale are shown in Figure 4.

Figure 4 shows that consumers of orthopedic shoes are patients of the first, second and third levels of motor functions according to the GMFCS scale. At the same time, patients of the first level in most cases use orthopedic shoes, supplemented with an individual orthopedic insole. Patients of the second and third levels are more likely to use exclusively individual shoes. The interrelation of violations of the accuracy of movements with the form of cerebral palsy is important. So, in the atactic form of cerebral palsy, there is an imbalance associated with a defect in the regulation of the distribution of muscle tone in the muscle group that ensures the maintenance of the posture and the accuracy of movements.

In the spastic form, the biomechanical component of maintaining posture stability is disturbed, in the dyskinetic form, the extrapyramidal postural control is impaired. Disorders in the motor apparatus can be either primary, directly related to CNS damage, or arise due to root causes. A more detailed description of the types of disorders in the motor apparatus in cerebral palsy is shown in Figure 5.

Figure 4. Levels of motor functions according to the GMFCS scale

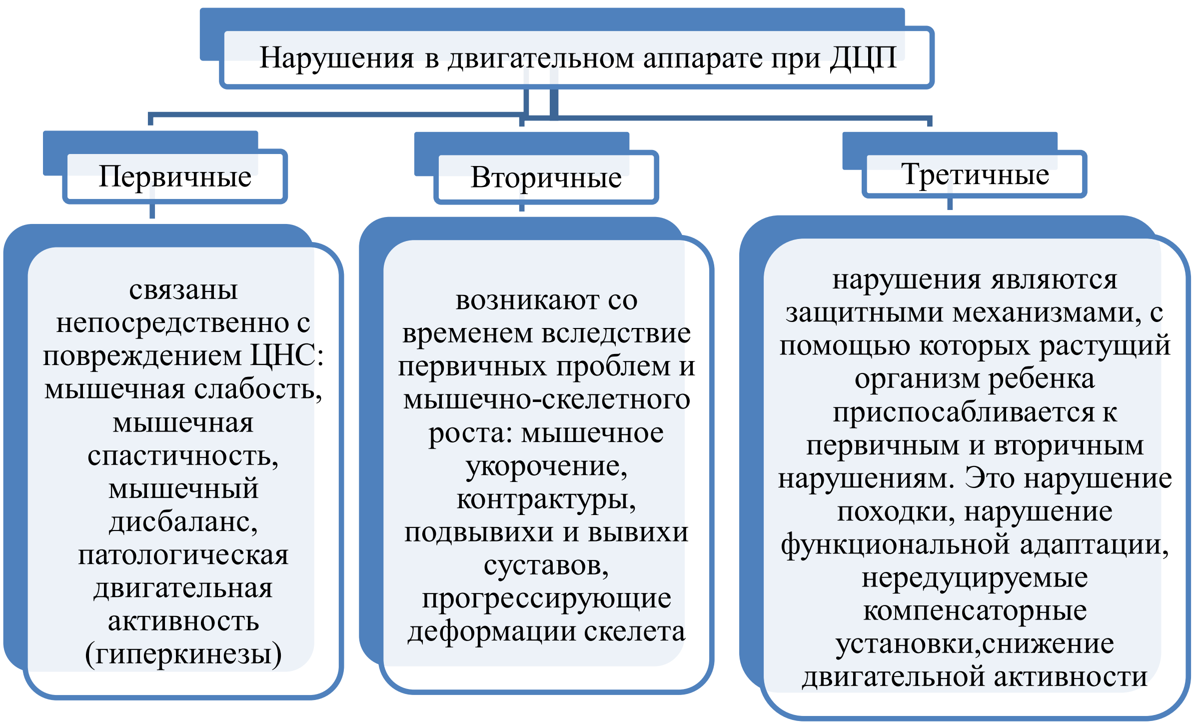


Figure 5. Types of disorders in the motor apparatus in cerebral palsy

An important characteristic of statics and movement, both of a healthy person and a person with cerebral palsy, is to find the position of the common center of gravity (center of mass) and its projection onto the support area. Distinguish between the common center of gravity (GCT) of the human body and the centers of gravity of its parts.

The common center of gravity of the whole body is an imaginary point to which the resultant of the gravity forces of all links of the body is applied. The BCT is composed of the centers of gravity of individual links of the body and affects the balance of the body and the degree of its stability.

When the posture changes, the GCM of the body shifts, and in some cases, in particular, when bending forward and backward, it can be outside the human body. The center of gravity of the foot is located on a straight line connecting the calcaneal tubercle of the calcaneus with the end of the second toe, at a distance of 0.44 from the first.

The analytical method for determining the GCC is based on the addition of the moments of gravity according to the Varignon theorem: "The sum of the moments of forces, relative to any center, is equal to the moment of the sum of these forces (or the resultant) relative to the same center."

Any body can be considered as a set of material points, which are, for example, molecules. Newton's laws for a material point are applicable almost without changes to a real body, if we introduce the concept of the center of mass (CM).

The mass of the body and the masses of its individual segments are very important for various aspects of biomechanics. To analyze the movements of the torso, the method of segmenting the human body is used: it is dissected into certain segments. For each segment, its mass and the position of the center of mass are determined.

Thus, compensation of balance disturbances in structures is achieved due to the balance of all parts of products used by humans. We extrapolate the above in relation to the design of orthopedic shoes.

When developing orthopedic shoes, it is necessary to focus on its weight. Shoe weight control is necessary to maintain or change the body's center of mass.

As shown above, the center of mass of the human body depends on the masses of the material points of which it consists. When calculating the center of mass, it is necessary to take into account the weight of the technical means of rehabilitation (TCR), in particular, orthopedic shoes, the weight of which will also affect the change in the center of mass. STO 46429990-010-2015 "Children's shoes with leather uppers" and the Technical Regulations of the Customs Union TR TS 007/2011 "On the safety of products intended for children and adolescents" it follows that the weight of small children's shoes should not exceed 300 gr .; preschool - 380 gr. and relate to mass-produced casual shoes. GOST R 54407-2011 “Orthopedic footwear. General Specifications” states that the mass of orthopedic shoes with individual manufacturing parameters is not regulated.

However, there are cases in which the weight in half-pairs of shoes is different. This may be due to the different composition of the corrective elements of the insole; the weight of the materials of the upper parts of the shoe, caused by the design features in general or the features of the frame parts; the weight of the fittings, determined by the design features; the weight of the soles associated with the presence of corrective elements (shortening compensation due to the sole, heel extensions, etc.). Figure 3.46 shows a sample of shoes, in one of the half-pairs of which the frame part is fixed on the foot with a metal buckle.

At the same time, the difference in the weight of the right and left semi-pairs is 86 grams. Thus, wearing shoes with different weights of semi-pairs manifests itself in the difference in weights of body segments (lower limbs) and leads to a shift in the general center of gravity, the position of which affects the biomechanics of movement.

Figure 6. Shoe sample with different weights of semi-pairs

The author considers the body of a healthy child as a system of material points with a known center of mass (CM), and claims that its mass is uniformly distributed relative to the axis of symmetry. Thus, the child maintains a state of balance, equalizing the internal forces of the body. In the event that the human figure has any morphological disturbances, the condition for maintaining balance remains unchanged, but in such a situation the child is forced to compensate for the displacement of one of the body segments by changing the position of the others, thereby making up for the lack of mass and equalizing the torque. When a load is added to one of the body segments, the CM torque changes. Thus, knowing the coordinates of the CM of the system, we can assume that by shifting the center of mass of one of the segments of the body, and thereby changing the torque, the child's body will strive to return the CM point of the whole body to its original position. It follows that maintaining the conditions of balance equilibrium is a key point in the design of products for cerebral palsy. The main task in developing the design of shoes is to find the placement of fixing parts to ensure a minimum amplitude of oscillatory movements and increase the sensations of one's own body.

Based on the foregoing, we propose a methodology for developing designs of orthopedic shoes that provide balance. It includes:

analysis of the morphological features of the figure and deformities of the lower extremities of the child;

obtaining a digital image of the child's figure;

building a balanced geometric spatial and conditional mechanical models of the child's body;

determination of the location of the fixing parts for weighting agents;

testing the balance of the child's body.

By the definition of "details-fixators" we mean tuning details-pockets on the berets of shoes, which are designed to accommodate weighting agents in them.

According to the results of testing the body balance of a child with cerebral palsy, depending on the morphological features, we proposed the topography of the location of fixing parts for weighting shoe structures (Table 6).

Table 6. The location of fixing parts in shoe designs depending on the morphological features of a child with cerebral palsy

Morphological features of the patient	The direction of the effect of the weighting agent	The location of the weighting element
Lower limb flexor contractures	It is necessary to influence muscle groups with reduced tone	The clamps are placed in the lower parts of the tibia with an anterior displacement
Supination of the foot	It is necessary to influence the foot from the inside to turn to the correct position.	Clamps are located at the bottom of the berets on the inside
Foot pronation	It is necessary to influence the foot from the outside to turn to the correct position.	Clamps are placed in the lower part of the berets from the outside
Atonic-astatic form of cerebral palsy	A weighting effect is necessary to reduce the amplitude of oscillatory movements	It is advisable to combine with a suit with weighting agents. In the design of shoes, place clamps on the berets in the ankle area

When developing the design, it must be taken into account that the maximum weight of all weighting agents in the fixing parts placed on a half-pair of shoes should not exceed 1.5% of the body weight.

As weighting agents, it is recommended to use steel or lead shot, the specific gravity of which is 7.8 and 11.3 g/cm3, respectively.

To develop health-saving designs of orthopedic shoes for children with cerebral palsy, you need to know the parameters of their feet and the park of technological equipment that is used to make such shoes.

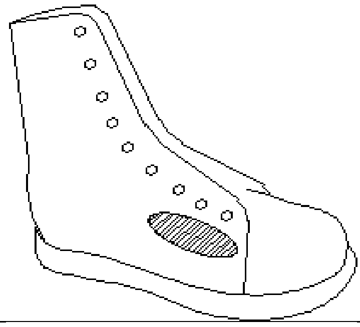
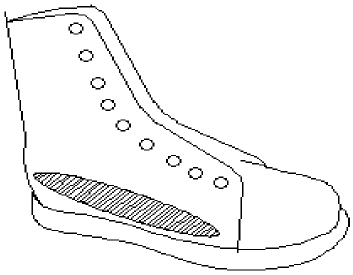
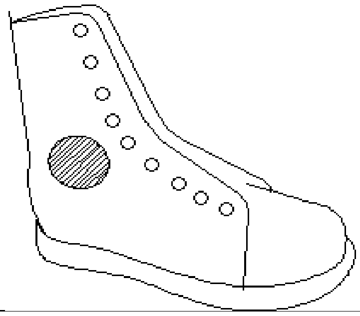
In the practice of prosthetic and orthopedic enterprises for children with cerebral palsy, as a rule, complex orthopedic shoes are made, which are divided into two groups: corrective, for correcting deformities that can still be corrected, and compensatory, the purpose of which is to compensate for various incurable deformities.

GOST R 55638-2013 "Services for the manufacture of orthopedic shoes" provides a classification of services for the manufacture of orthopedic shoes by methods, which includes the individual manufacture of orthopedic shoes and the selection of orthopedic shoes. The composition of services for the manufacture of these types of shoes is different.

Depending on the location of the tuning parts-pockets for weighting agents that provide balance balance, products can be classified into 9 groups (table 7).

Impact Factor:
ISRA (India) = 6.317 | SIS (USA) = 0.912 | ICV (Poland) = 6.630
ISI (Dubai, UAE) = 1.582 | РИНЦ (Russia) = 3.939 | PIF (India) = 1.940
GIF (Australia) = 0.564 | ESJI (KZ) = 8.771 | IBI (India) = 4.260
JIF = 1.500 | SJIF (Morocco) = 7.184 | OAJI (USA) = 0.350

Table 7. Classification of shoes depending on the location of pockets for weighting agents that provide balance

Location of tuning parts-pockets for weights	Illustration
in the lower parts of the tibia on both sides with an anterior displacement	
in the lower part of the tibia from the outside with an anterior displacement	
in the lower part of the tibia on the inside with an anterior displacement	
in the lower part of the berets on both sides	
in the lower part of the berets from the outside	
in the lower part of the berets from the inside	
on berets on both sides in the ankle area	
on the berets from the outside in the ankle area	
on the berets from the inside in the ankle area	

In case of individual production, instead of the service "Selection of finished orthopedic shoes in accordance with GOST R 54407-2011", a number of services are introduced (determining the parameters of special orthopedic parts and choosing materials for their manufacture; determining parameters or obtaining initial data for a mathematical model (scanning) of the foot and lower leg consumer; selection and adjustment or production of individual technological equipment, production of orthopedic shoes, including fitting), which significantly increase labor and material costs, as a result of which the cost of the product increases. Therefore, it is economically beneficial to increase the share of services for the selection of orthopedic shoes, followed by equipping with an insert orthopedic insole and additional corrective elements.

When transferring shoes from the status of individual production to the status of "selection", it is necessary to satisfy the needs of the customer as much as possible by developing designs with a set of corrective elements designed for various deformities of the lower extremities. From the analysis of research sections, subsequent descriptions of the features of cerebral palsy disease and the possibilities for improving the designs of products for people with cerebral palsy, it can be concluded that the range of orthopedic shoes includes designs that provide a different level of rehabilitation effect. This gives us reason to approach the classification of these types of shoes from the standpoint of customization. Such a trip is attractive primarily for ethical reasons: the consumer feels that the product (in this case, shoes) is made personally for him and satisfies his personal needs to customize - customize, change something, making it more suitable for the needs of a particular consumer) is interpreted as the individualization of products for the orders of specific consumers by making structural or design changes (usually at the final stages of the production cycle). Consider a model of the life cycle of orthopedic shoes in terms of customization. At its core, the model is staged with the possibility of iteratively repeating some of them (Figure 7).

Figure 7. The life cycle of the product development process in terms of customization

Figure 7 shows that at the first stage, a general idea is formed about the product, its main functions and the tasks solved with its help. To develop designs for orthopedic shoes, it is very important to get as much information as possible and fix it in the source documents. However, it should be borne in mind that not all the wishes of the customer can be reflected in the terms of reference (TOR), especially with an integrated approach to the decision to create a product, which is orthopedic shoes: some positions may contradict each other or be simply untenable due to various circumstances (for example, organizational and technical). However, this cannot serve as a basis for their exclusion. At the second stage, the design of the product is carried out, on which sketches, drawings, technological and instructional maps are developed, other data and documents necessary for the manufacture of a product sample. Thus, the following stages of the life cycle of shoes in general are covered: market analysis (search for a product idea) - preliminary design - design - creation of experimental samples - production, which determine important points in the formation of shoe quality.

The production itself is a key element in the life cycle of an orthopedic product: shoes are made, which are tested during fitting. At the same time, a discrepancy in the prototype elements is allowed (for example, additional fastenings or other fittings that determine the degree of fixation of the shoe on the foot), which, in accordance with earlier decisions, were secondary. The data obtained make it possible to evaluate not only the technical, but also the price characteristics of the product and decide on the advisability of its further development.

If a decision is made to continue the customization process, then product development moves on to the next stage - making changes and corrections. Appropriate amendments must be made to all design and technological documents. The stages of designing and making subsequent changes can be repeated several times until a result is achieved that satisfies all the requirements of the Customer. Experience in the manufacture of orthopedic shoes shows that the number of iterations is usually one or two, and almost never exceeds three.

Various levels of individualization in the assortment of orthopedic shoes, all designs from the standpoint of customization can, in our opinion, be divided into ultra-customized masses.

The definition of mass-customized orthopedic shoes is understood as shoes, the design of which is developed on the basis of the average typical features of a group of patients homogeneous in terms of diagnosis. Customization is carried out by adjusting the insert corrective elements, the design features of the models that regulate the volume of the shoe space and frame parts that provide a rehabilitation effect. Ultra-customized shoes are models designed taking into account the individual anatomical features of the foot of a particular patient based on typical designs of mass-customized shoes.

Wearing orthopedic shoes forms the correct walking stereotype, suppresses hyperkinesis, eliminates contractures, prevents the development of foot deformities, and develops motor skills. The rehabilitation effect of orthopedic shoes depends on the shape and size of the shoe space, which in turn is determined by the shape and size of shoe lasts.

Having studied the range of lasts of prosthetic and orthopedic enterprises, we have compiled a classification of shoes according to the degree of conformity of their internal shape to the patient's foot:

orthopedic shoes made on blocks corresponding to GOST or TU;

orthopedic shoes made on blocks, the dimensions of which are adjusted to the individual parameters of the feet;

orthopedic shoes made individually from a plaster cast of the foot, or based on its 3D scans.

Within the framework of this monograph, the parameters of shoe lasts were refined to create mass-customized shoes for prosthetic and orthopedic enterprises in the regions of the Southern Federal District and the North Caucasus Federal District.

To do this, we carried out anthropometric studies of the feet of children with cerebral palsy, as well as measurements of the parameters of Russian-made orthopedic shoe lasts, which are used at prosthetic and orthopedic enterprises in the regions of the Southern Federal District and the North Caucasus Federal District for the manufacture of orthopedic shoes.

According to statistics, in the regions of the Southern Federal District and the North Caucasus Federal District, there are about 2,000 children with cerebral palsy. Let's take this number as the total population of the sample. Then for a 85% confidence level and a 5% confidence interval, the required sample size is 390 people.

On the territory of the cities of Rostov-on-Don and Krasnodar, measurements were taken of the feet of 390 children aged 2-17 years with various forms and severity of cerebral palsy. The experiment involved children growing up in families and in specialized institutions.

According to the research results, it was found that for a larger number of measured foot lengths are in the range from 145 to 200 mm. According to GOST 54407-2011, this corresponds to the sizes of small children and preschool groups of shoes, which include girls and boys from 3 to 7 years old. The proportion of children aged 4-7 years is 18.1%. Consequently, the general population of the sample for this sex and age group is 267 people. With a 95% confidence level and a 5% confidence interval, the required sample size is 217 people. The number of measurements in this sex and age group is 220 people, which allows further research.

Foot measurements were taken on a thin toe. Foot length was measured using a stopometer. The scheme for obtaining the girth parameters of the feet for the selection of lasts in the manufacture of shoes is necessary: parameter No. 1 - the girth of the foot in bundles; parameter number 2 - the girth of the foot in a straight lift; parameter No. 3 - oblique foot girth; 4 - girth of the lower leg above the ankles.

Measurements of the latitudinal parameters of the feet are made only in the case of the manufacture of an individual block.

In the manufacture of shoes for children with cerebral palsy, in most cases, tibia blocks are used, since the designs cover the ankle and have frame parts to maintain and normalize the biomechanics of the foot. The value of the parameters of the tibial tube of the blocks depends on the length of the track. From statistical data processing it follows that the height of the tibia with a foot length of 140-150 mm should be 140 mm, with a length of 150 to 180 mm - 150 mm and from 180 to 190 mm - 160 mm.

The height of footwear is regulated by GOST R 54407-2011 “Orthopedic footwear. General technical conditions”, but it is allowed to change it as prescribed by an orthopedic doctor. The recommended GOST R 54407-2011 parameters for the height of the berets of orthopedic shoes made for selection are shown in Table 8.

Table 8. Recommended heights of the berets of orthopedic shoes made for selection

Gender and age group	Shoe size	Shoe height, mm, not less than		
		Recommended	0.3L+59	0.3L+63
Little children's	135	100	99.5	
	145	105	102.5	
	155	110	105.5	
	165	110	108.5	
preschool	155	110		109.5
	160	115		111.0
	165	115		112.5
	170	115		114.0
	175	120		115.5
	185	120		118.5
	190	125		120
	195	125		121.5
	200	125		123

For further research, we measured three lines of shoe lasts intended for the manufacture of orthopedic shoes for patients with cerebral palsy. Orthopedic shoes must meet not only a set of technological, but also medical requirements. When measuring the feet of patients, medical prescriptions for orthopedic insoles were recorded by the doctor.

So, a product with a removable orthopedic insole should correspond to the anatomical structure of the foot and ensure its normal functioning. Loose shoes do not contribute to the necessary function of correcting the pathology: due to slipping of the foot inside the shoe, abrasions and calluses can form. Excessively tight shoes violate the physiology of the foot, causing injury and progression of deformities.

Thus, in the manufacture of mass-customized orthopedic shoes, an additional volume of intra-shoe space for an orthopedic insole must be provided.

The removable orthopedic insole is made of leather, thermoplastic and other materials, no more than 3 mm thick. On the corrective elements of the insole, such as arch support, pronator, arch lining, etc. foam or thermoplastic materials are used. The size and position of the corrective elements is prescribed by an orthopedist, based on the nature and degree of foot deformities. For further research, we have compiled a classification (Figure 8) of corrective elements (CE) according to their position in the shoe space.

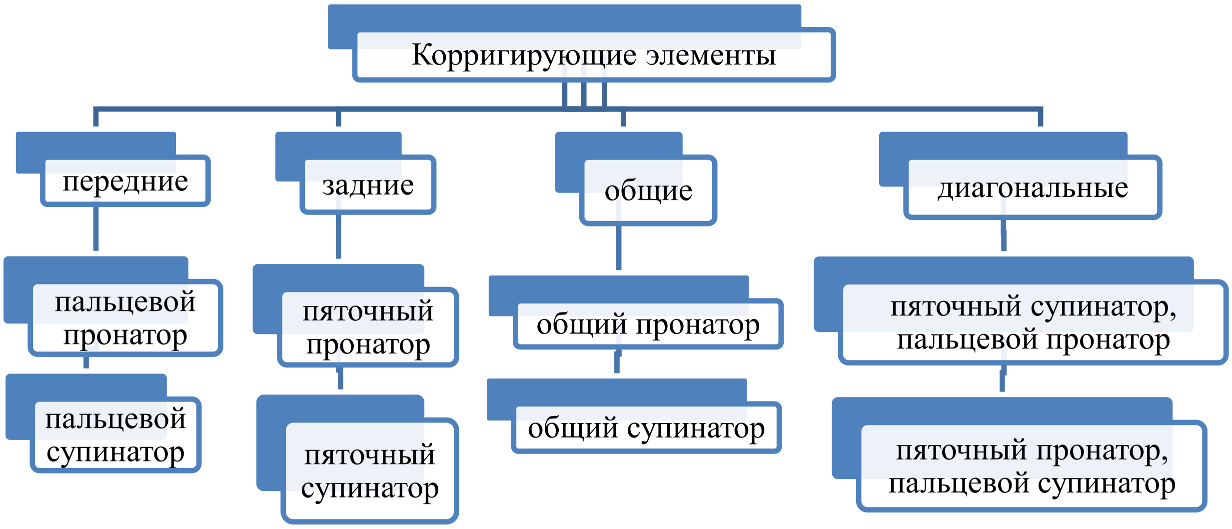


Figure 8. Classification of corrective elements according to their position in the shoe space

Based on the analysis of medical prescriptions for patients with cerebral palsy, carried out at enterprises in the regions of the Southern Federal District and the North Caucasus Federal District, we compiled a diagram of the distribution of the frequency of use of corrective elements (CE) in shoes for children with cerebral palsy (Figure 9).

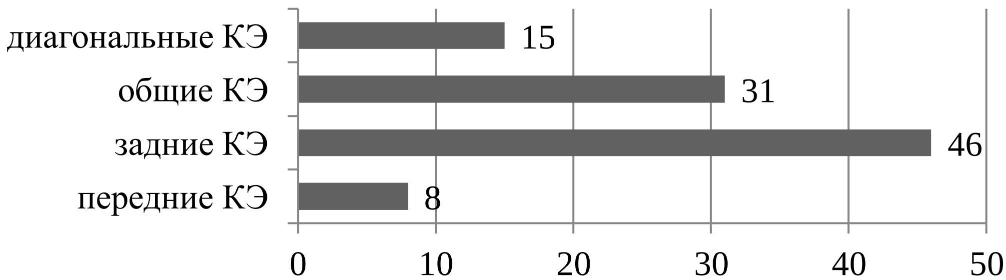


Figure 9. Distribution diagram of the frequency of use of corrective elements in shoes for children with cerebral palsy

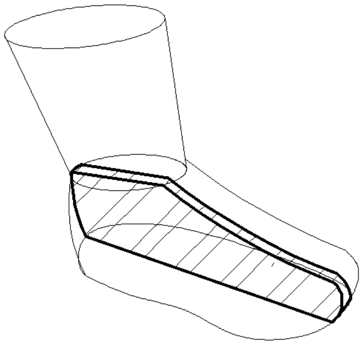
The designs of mass-customized shoes for children with cerebral palsy have intermediate frame parts for fixing the ankle joint. This element of footwear can be made of leather of increased thickness or thermoplastic materials. In order to avoid injuries to the child's foot in the form of corns and abrasions during the operation of shoes, the structures are equipped with an unlock in the ankle area, which provides additional space between the frame parts and the patient's foot. At the same time, it is recommended to duplicate the unblocked area during the production of shoes with a soft rubber-like material. The height of the tube of the last must be at least 10 mm higher than the workpiece of the top of the shoe. This ensures the convenience of molding the frame parts of the shoe in the area of the berets. Taking into account the requirements and results of measuring the feet of patients, a table has been compiled, To test the results obtained, we took pads from the Rostov Orthopedic Factory, the parameters of which were brought to those established by the results of the studies performed (Figure 10).

a

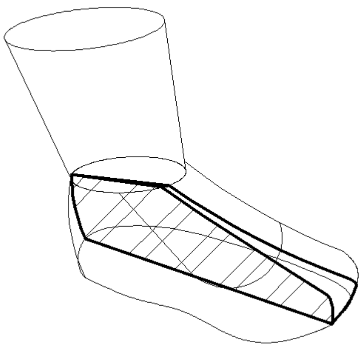
b

Figure 10. Blocks: a - original form; b - brought to the set parameters

These lasts were used to make shoe lines, which were offered to patients as ready-made or fitting shoes. The design of orthopedic shoes with a high tibia and with vertical flat and wedge-shaped inserts is shown in Figure 11.



a



b

Figure 11. Structural diagrams with vertical flat(a)and wedge-shaped(b)inserts

The shoes have a double-sided hard beret and a removable orthopedic insole, which can be supplemented with the necessary corrective elements. Below are the main principles of the concept of developing such a design:

take the minimum girths of the foot obtained during the study as the parameters of the initial block;

to adjust the "girth in bundles" parameter, a set of wedges is offered that increase the girth in 5 mm increments. An increase in the girth of the feet can be caused by a large fullness, deformity of the fingers, flattening of the forefoot. Therefore, both vertical and horizontal wedges are needed;

the girth of the lower leg above the ankles is measured in 5 mm increments. Therefore, the size of the wedges should increase the volume of the block tube with the same step;

in some cases, an increase in ankle releases is required. To do this, it is necessary to provide a technological hole in the design of the block for installing the blocking cloth.

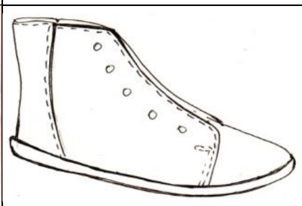
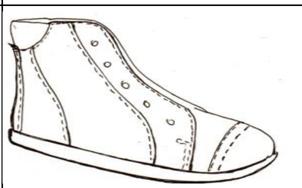
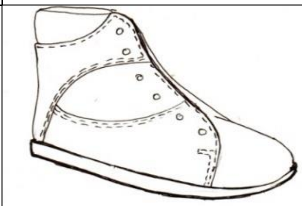
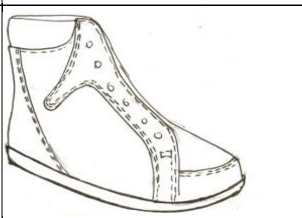
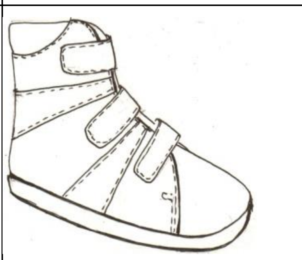
In addition to the internal shape of the shoe, the degree of the rehabilitation effect is affected by the design of the product, therefore, the next section is devoted to the analysis of the range of children's orthopedic shoes for patients with cerebral palsy.

The range of children's orthopedic shoes is wide, so its classification and identification of basic models are required. To solve this problem, we analyzed the designs of shoes produced by Russian enterprises specializing in the manufacture of orthopedic shoes.

Thus, envelope-type structures are manufactured by prosthetic and orthopedic enterprises in Rostov-on-Don, Stavropol, Krasnodar, Sochi, Kirov, Lipetsk, Kaliningrad, Rostov, Syktyvkar.

Table 9 shows photographs of insulated footwear models taken from the production catalogs of orthopedic enterprises. For clarity, the designs are transformed into a technical drawing when describing their structural elements.

Table 9. Boot designs with adjustable berets

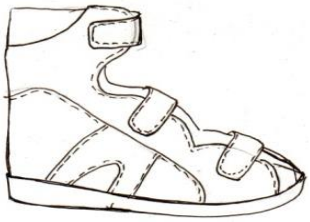
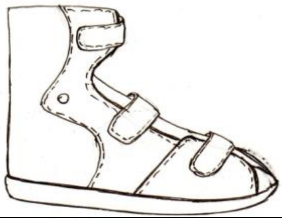
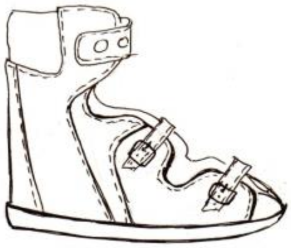
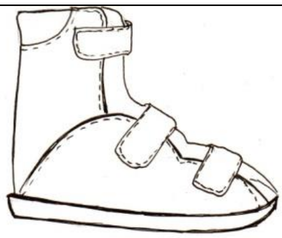
Product illustration	technical drawing	Structural and decorative elements
		Lace-up boots with soft piping. Decorative stitching used as decoration
		Lace-up boots. Adjusting decorative elements of a contrasting color are used as decor.
		Lace-up boots with soft piping. Used as a decor: articulation of details, details of contrasting colors
		Lace-up boots with soft piping. Used as a decor: a combination of colors, stitching in a contrasting color
		Lace-up boots with soft piping. Partitioning of details, details of neutral colors were used as decor.
		Velcro boots with soft piping. Used as decor: articulation of parts, details of related colors

The most popular design is the "envelope" type boots with berets that cover the ankle for the use of frame details. Good opening is required in shoes, which is achieved by lengthening the berets to the V base line or going beyond it. Methods for fixing the model are different, laces are the priority, but the use of Velcro tapes and buckles is not excluded. A variety of designs in this case is achieved through the division of parts, the use of fittings and various color schemes. Orthopedic shoes with a high tibia and a full opening for the entry of the foot are the most popular among summer models, as they can be prescribed for various deformities of the lower extremities. Product illustrations, technical drawings and design descriptions are shown in Table 9. When analyzing designs, 3 main methods of fixing shoes on the foot are distinguished: laces, Velcro tapes, buckles. Laces along the entire arc of divergence for the entrance of the foot create the greatest degree of fixation in the ankle joint due to the minimum possible distance between the fixing elements (laces threaded through the blocks and changing the full parameters of the shoe by tightening or relaxing the lacing. In the production of shoes, there are combined methods of fixation on the foot The most popular combination is "velcro tape - buckle". This is due to the convenience for the patient to put on and take off shoes on his own. Due to impaired motor skills, the use of a buckle with a buckle is almost impossible in most cases.

Consider the design of summer shoes with high berets and a vamp with an elongated tongue fixed with straps. Due to the vamp with an overestimated tongue in the shoe, enhanced fixation of the ankle joint is achieved. Design options for this model are shown in Table 10.

The closed beam part of the shoe makes it difficult to put on shoes for patients with severe ankle joint contractures and foot paresis. There are 2 methods of fixing shoes on the foot: Velcro tapes and buckles, as well as in the previous model, their combination is possible.

Table 11. Designs of summer shoes with an open toe

Product illustration	technical drawing	Structural and decorative elements
		Shoes with soft edging on Velcro tapes. Used as decor: articulation of parts, combination of colors, appliqué
		Velcro shoes. Used as decor: articulation of parts, combination of colors, appliqué
		Shoes with soft edging on Velcro tapes and buckles. Used as decor: articulation of parts, combination of colors, appliqué
		Shoes with soft edging on Velcro tapes. Used as decor: division of parts and a combination of colors
		Shoes with soft edging on Velcro tapes. Partitioning of parts was used as a decoration

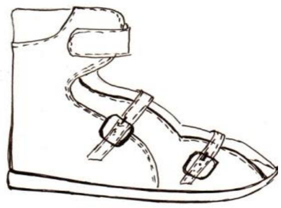
		Shoes with soft edging on Velcro tapes and buckles. Used as decor: division of parts and a combination of colors

Table 12. Designs of summer shoes with high berets and a vamp with an elongated tongue

Product illustration	technical drawing	Structural and decorative elements
		Summer shoes with a closed toe and vamp-tongue. The fixation method on the foot is Velcro tapes. Used as decor: division of parts and a combination of colors
		Summer shoes with a closed toe and vamp-tongue. The fixation method on the foot is Velcro tapes. Used as decor: articulation of parts, combination of colors, appliqué
		Summer shoes with a closed toe and vamp-tongue. The fixation method on the foot is Velcro tapes. Used as decor: articulation of parts, combination of colors, appliqué
		Summer shoes with a closed toe and vamp-tongue. Method of fixation on the foot - belts with buckles. Unusually shaped buckles and a preformation on the vamp were used as decor.
		Summer shoes with a closed toe and vamp-tongue. Method of fixation on the foot - belts with buckles. Used as decor: stitching in a contrasting color and perforation on the vamp

The third model is summer shoes with high berets and a closed toe (Figure 12).

The model has a number of limitations: it is categorically not suitable for patients with severe ankle joint contractures, foot paresis, toe deformities, etc.

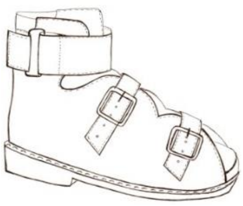
Figure 12. Models of summer shoes with an overestimated part of the berets and a closed toe

Figure 13. Model of summer shoes with a vamp increased due to the belt

To prescribe such a design to patients with foot paresis or minor contractures, it is necessary to shorten the allied part of the shoe for easy entry of the foot into the shoe space. To obtain a constructive norm for the length of the vamp, a Velcro tape with a width of 2.5 cm or more is used, which lengthens the vamp part of the shoe (Figure 13).

Thus, 4 main shoe designs for patients with cerebral palsy have been identified. Let's take them as base. Examples of structures and their description are given in table 13.

Table 14. Description of the basic models of orthopedic shoes for patients with cerebral palsy

Boots	Summer shoes with a high tibia		
tuning berets	open toe	closed toe (toe with extended tongue)	closed toe (toe without tongue)
			
			

Various modifications of these models can be obtained by dividing the parts, using decorative tuning parts, decorative elements and fittings to ensure a comfortable condition for the child's foot. The most common concomitant deviations of the lower extremities in cerebral palsy are: flat feet, hollow foot, valgus deformity of the feet, foot paresis, shortening of the lower extremities, various deformities of the fingers. This requires the introduction of certain additions to the design of shoes. Shoes for children with cerebral palsy should be made of high quality materials. Distinctive features are specially designed pads that have a wide toe to ensure the natural position of the toes and the child's foot is not deformed and occupies a comfortable position. In shoes, it is recommended to use soles with sufficient elasticity and flexibility. Some models have a prophylactic sole with a special heel with an elongated crocodile to support and unload the foot. This is a heel extended from the inside of the sole. This reinforces the sole under the midfoot and prevents it from sinking inward. The use of a heel helps both in the prevention and treatment of foot defects. Orthopedic provision of patients with a drooping foot is determined by active mobility in the ankle joint, as well as the presence of lateral deviations of the foot. In cases where dorsiflexion in the ankle joint is preserved and there are no lateral deviations of the foot, shoes are prescribed in combination with a cuff and rubber bands. If the sagging is not fixed and there are slight lateral deviations of the foot, it is recommended to use orthopedic boots in combination with a cuff and rubber bands, as well as shoes with double lacing. Pronounced lateral deviations of the sagging foot require the appointment of orthopedic boots with one-sided hard berets and heel extension, and the intersole layer should be supplemented with a pronator or arch support. With a fixed sagging or excessive mobility in the ankle joint, boots with bilateral or circular hard berets are recommended. The circular rigid beret, along with a more secure fixation, creates some front stop, which is necessary for the implementation of the roll. The product range is limited. Recommended designs for children with cerebral palsy are boots and high sandals.

Table 14. Calculation of the parameters of custom-made orthopedic shoes

Gender and age group of shoes	Shoe height, mm, not less than
Toddler boot	0.3/ + 53

When designing orthopedic shoes, in addition to the intra-shoe space and the parameters of the orthopedic insole, a significant rehabilitation effect is achieved through frame parts.

The degree and topography of the rigidity of the product is determined taking into account the entire complex of foot deformities. Special frame parts of orthopedic shoes for children with cerebral palsy include a hard heel counter, hard berets, hard toe cap, hard vamp, hard barrel, etc. A hard barrel in most cases is combined with a hard corset, berets or back. Statistics on the use of frame parts for fixing the ankle joint according to the Rostov Orthopedic Factory of the Ministry of Labor and Social Protection of the Russian Federation is shown in Figure 14.

Figure 14. Frequency of use of skeletal parts for fixation of the ankle joint

Prevailing in frequency of use are a hard beret in combination with a hard barrel (41%) and without it (22%). Shoes with double-sided hard berets in combination with a hard barrel are recommended in mass-customized shoes for people with cerebral palsy. The degree of fixation of the foot in the intra-shoe space is influenced by the methods of fixing shoes on the foot. Typical fixation methods are shown in Figure 15.

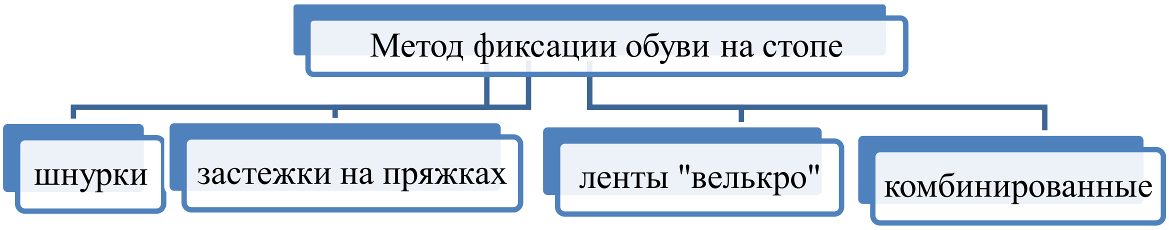


Figure 15. Methods for fixing shoes on the foot

The traditional ways of fastening shoes on the foot, providing a secure fit of the foot in the inside of the shoe space, are laces. In this case, the volume inside the shoe space can vary with high accuracy, while increasing the rehabilitation effect of orthopedic shoes. With the development of technology and changes in fashion trends for children's shoes, orthopedic shoes use the fixation method on the foot with the help of Velcro tape, which is used by fashion designers in various types of shoes. In the design of footwear, on average, from 2 to 4 Velcro tapes are used, spaced evenly at a distance of 2–3 cm from the edge of the berets. This is enough to fix on a healthy foot of a child. But, when it comes to maximum fixation with frame parts, the use of Velcro tapes cannot create sufficient fixation of the foot in the shoe space. The foot does not take a fixed position, therefore, the therapeutic and prophylactic significance of shoes is reduced.

To ensure the necessary degree of fixation of shoes on the foot with Velcro tapes, it is proposed to design recesses in the berets at the bend of the ankle joint, thus changing the distribution of resistance forces. An example of the proposed design solution is shown in Figure 16. In the design of the presented type, Velcro tapes are located in two directions: to fix the lower leg and the back of the foot. Not only the fixation of shoes on the foot increases, but also the comfort of using the product. The design provides a qualitative relationship between consumer preferences and medical prescriptions. This model is included in the assortment of the Rostov Orthopedic Factory and is actively used.

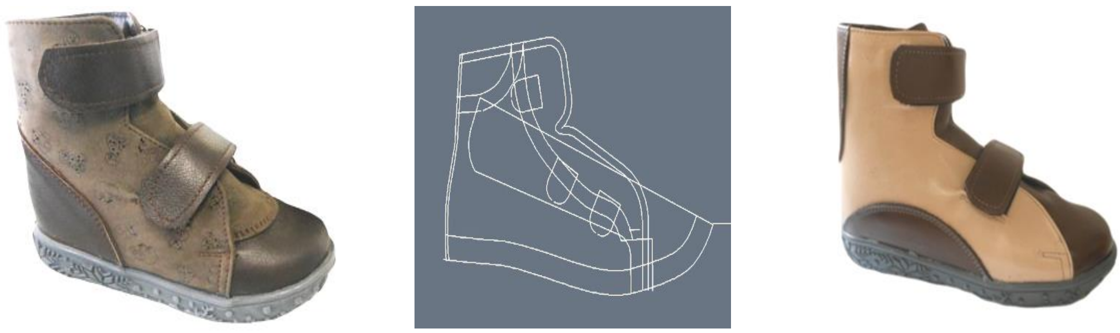


Figure 16. Options for changing the shape of the berets of orthopedic shoes

When analyzing the designs of orthopedic shoes from the point of view of fixing the foot in the shoe space, which is achieved due to frame parts, fixation methods on the foot and volumetric parameters of shoe lasts, 3 main degrees of fixation can be distinguished: weak; increased; significant. Figure 17 shows a drawing of the design of shoes with a high hard back (shaded) with a weak degree of fixation. The shoe design is prescribed for minor deviations in the lower extremities. The rigidity of the backs is ensured by using polymeric materials or leathers of increased thickness.

Buckles, velcro straps, or laces are recommended methods for securing the shoe to the foot in these designs. In the model with an increased degree of fixation of the foot (Figure 18), a high rigid beret is used as frame parts (shaded). Buckles and laces are the recommended methods of securing shoes to the foot.

In the model shown in Figure 19, the frame parts are high rigid berets in combination with rigid barrels, which provides a significant degree of fixation. This shoe design is designed for children with significant deformities of the lower extremities.

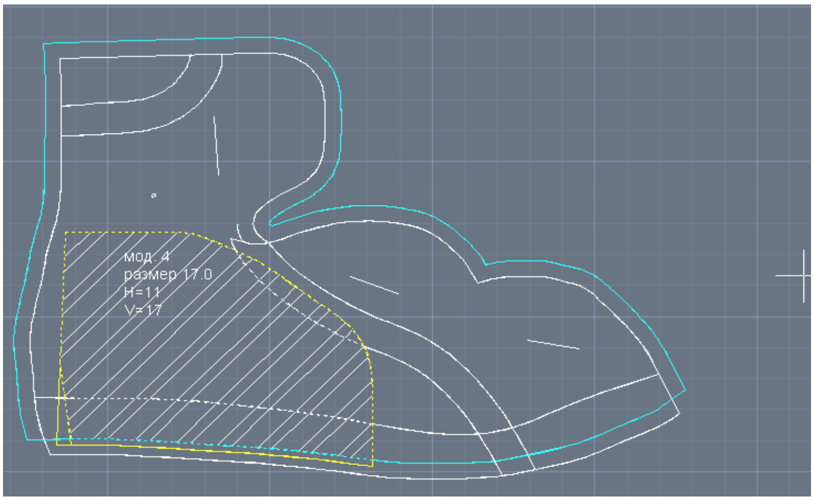


Figure 17. The design of shoes with a high rigid back (with a weak degree of fixation of the foot in the shoe space)

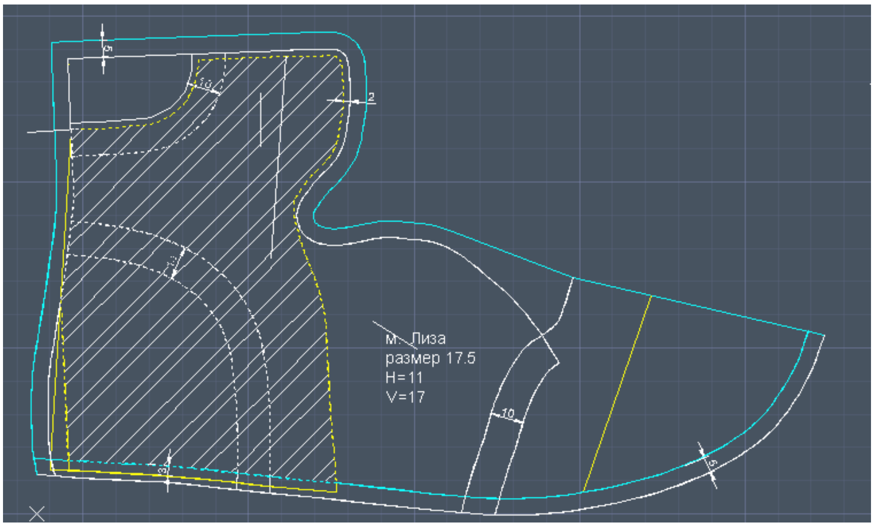


Figure 18. The design of shoes with a rigid ankle (with an increased degree of fixation of the foot in the inside of the shoe space)

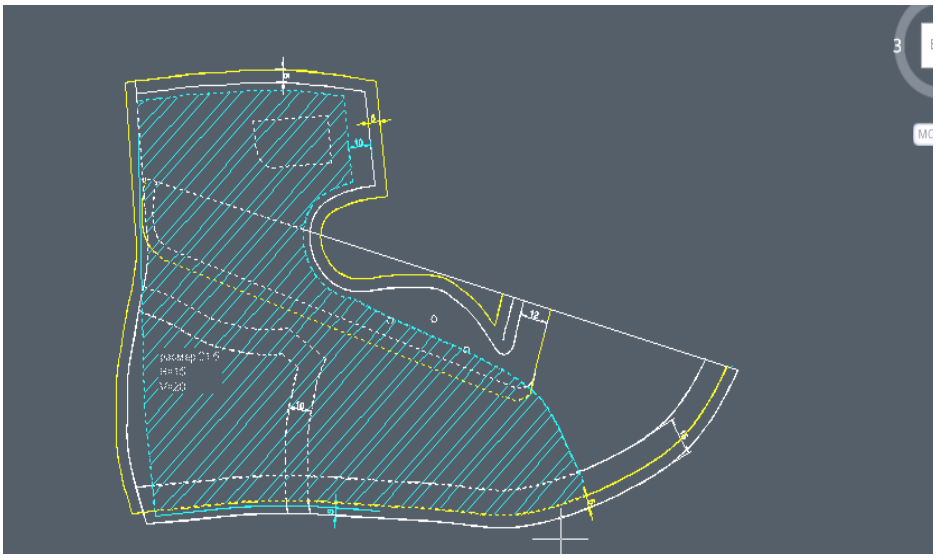


Figure 19. The design of shoes with hard berets and hard barrels (with a significant degree of fixation of the foot in the shoe space)

The presence of extensions in the calf part significantly increases the fixation of the foot in the shoe space in comparison with the previous design. The recommended methods of fixation on the foot are buckles and laces. Summarizing the data concerning orthopedic insoles, frame parts, methods of fixing shoes on the foot, as well as solutions for typical shoe designs, we proposed to distinguish 7 levels of rehabilitation properties of structures. These levels characterize the main functions of rehabilitation when using orthopedic shoes. The classification scheme is shown in Figure 20.

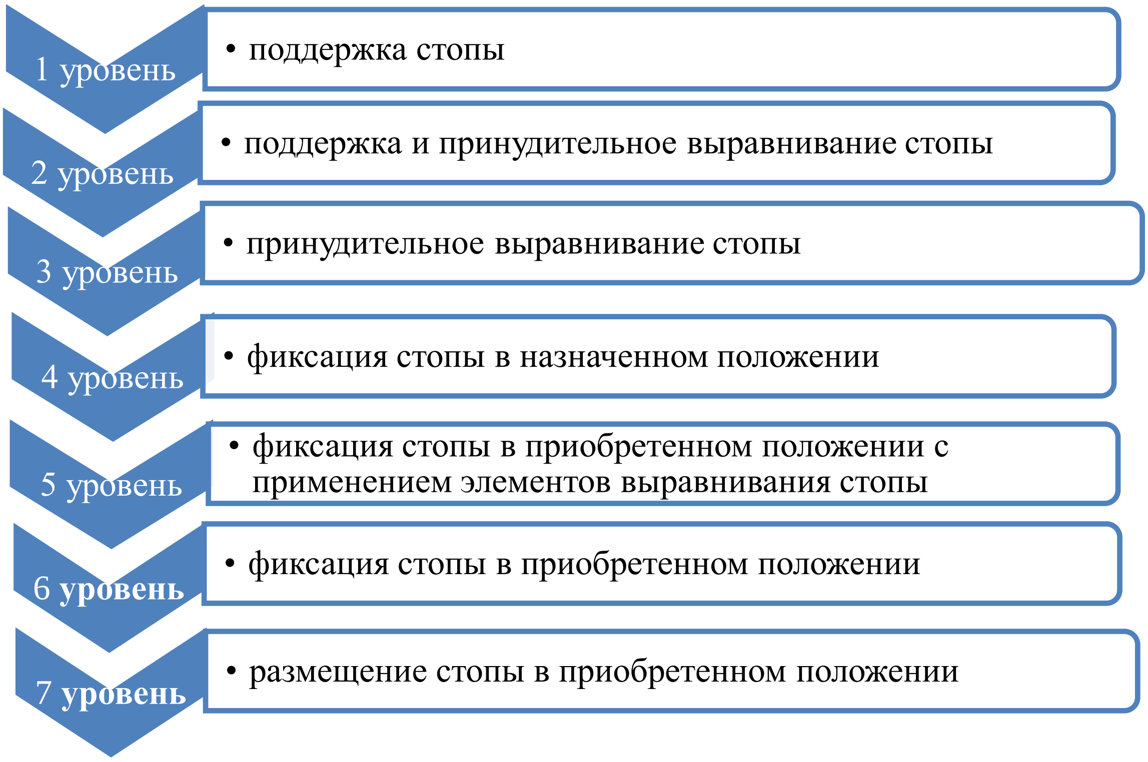


Figure 20. Classification of the rehabilitation properties of orthopedic shoe structures

It follows from the scheme that for patients with 1-3 levels of motor functions, shoes are made according to the GMFCS scale. For levels 2 - 5, lasts must be used in accordance with GOST R 53800-2010 "Orthopedic shoe lasts. General technical conditions", or individual pads with parameters as close as possible to the parameters obtained during the measurement of the feet. Particular attention should be paid to the angle between the running and tibia parts of the block. In shoes of levels 2 - 5, the angle remains fixed, which has a rehabilitative effect. Level 6 and 7 shoes can be made from casts of the foot. The angle between the running and tibial part of the foot can be prescribed by an orthopedic doctor based on the results of the examination of the patient. A more detailed description of frame parts, orthopedic insoles and shoe designs in terms of the level of rehabilitation effect is given in Table 15.

Table 15. Classification of shoes according to the level of rehabilitation effect

Levels	frame details	Features of the orthopedic insole	Shoe design features
1	hard back	vault support	shoes with a high tibia with any method of fixation on the foot
2	hard back	with arch support and additional corrective elements (pronator, supinator)	shoes with a high tibia with any method of fixation on the foot
3	high hard back or hard beret	with arch support and additional corrective elements (pronator, supinator)	shoes with a high tibia with any method of fixation on the foot
4	hard beret in combination with a hard barrel or the use of corsets	with arch support and additional corrective elements (pronator, supinator)	shoes with an overestimated tibia part with fixation on the foot with straps or laces

5	hard beret in combination with a hard barrel or the use of corsets	with arch support, additional corrective elements (pronator, instep support) and elements that compensate for foot deformities (insole according to the impression)	shoes with an overestimated tibia part of the “envelope” type design with fixation on the foot with straps or laces
6	hard beret in combination with a hard barrel or the use of corsets	with arch support, additional corrective elements (pronator, instep support) and elements that compensate for foot deformities (insole according to the impression)	shoes with an overestimated tibia part of the “envelope” type design with fixation on the foot with straps or laces
7	rigid back or other frame part necessary for movement	with elements that compensate for foot deformities	shoes with an overstated tibia part of the “envelope” type design with any method of fixation on the foot

To ensure a comprehensive rehabilitation effect of the design, in addition to the design features of the model, its color scheme is important, affecting the psyche of a child with cerebral palsy, which should be taken into account. There are numerous methods for designing various shoe structures: designing boots, boots, low shoes, pumps, moccasins and strap-sandals. In all cases, the design process is carried out on the last, implying the fact that the details of the right and left half-pair in the shoe set are symmetrical and do not differ in any way. When creating orthopedic shoes, asymmetries are often encountered, which gives us reason to pay attention to the peculiarities of the methods for developing such structures, which, in accordance with the terminology we have adopted, belong to the mass category and ultra-customized. Currently, various shoe design methods are used, including computer technologies based on matrices of basic geometric shapes of structural elements of the shoe shape. Specialized CAD designed for designing shoes (ShoeMaker, ASSOL-OBUV, ASKO-2D, IRIS, etc.) are widely used at shoe enterprises. They contain tools and functionality for the development and design of all types of shoes, as well as the creation of databases, which is not the case for small businesses or custom-made shoe shops. To improve the quality of drawings while reducing labor intensity and creating electronic databases, we propose a method for designing shoes using a wide range of CAD systems. The design of shoes according to the method is simple, manufacturable, structured, low material and labor costs. At the same time, the most common in the practice of prosthetic and orthopedic enterprises is the design of shoes according to the URC, obtained using paper templates, which includes the following steps:

development of a sketch of shoes;

obtaining an average sweep of the side surface of the block (URC);

inscribing the URC in the coordinate axes, drawing a grid of base, auxiliary and control lines;

drawing the constructive basis of the top of the shoe, internal and intermediate parts;

production of templates for shoe parts.

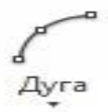
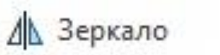
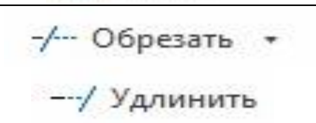
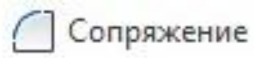
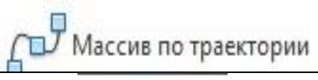
Therefore, we will present the content of the work of the proposed design methodology in comparison with that used in the practice of prosthetic and orthopedic enterprises (Table 16).

Table 16. Comparison of the stages of the original and proposed shoe design methods

Stage	Traditional Design Method	New Design Method
1	Obtaining a conditional sweep of the inner and outer sides of the side surface of the block. Obtaining the average sweep of the side surface of the pad (URK)	Applying a grid of basic, control and auxiliary lines to the block (method of V.F. Peshikov, Ars Sutoria). Drawing a sketch of the future model on the outside of the block. Get URC. Obtaining a sweep of the block trace.
2	Inscribing URC in the coordinate axes. Drawing a grid of basic, auxiliary and control lines	Construction of high-rise parameters of shoes based on the results of measurements of the customer's foot and the type of deformities of the lower extremities
3		“Trying on” gluing the resulting soil model of shoes onto a last with a note if further adjustments are needed
4	Drawing the structural basis of the upper, lining details and shoe interlining	Digitization of the contours of the model, construction of structural allowances. Construction of the lining and interlining of shoes
5	Obtaining shoe detail templates	Obtaining part templates from a finished drawing using the Copy and Paste commands
6		Entering the received drawing into the database with the necessary information

At the second stage, the URC is placed in conditional coordinate axes, taking into account the height of the heel and oblique girth. The upper edge of the shoe is designed with an angle of inclination of 84 - 86 degrees or based on the deformation of the foot. The slope of the upper edge is checked visually during the "fitting" of gluing the primer model on the block. In the program of the AutoCAD package for 2D design, the digitization of the contours of models and the correction of the drawing are carried out using the tools presented in Table 17.

Table 17. AutoCAD tools used in design

Tool designation	Tool functionality
	Outlining objects, building straight lines
	Lingering edge outline
	Construction of perforations, blocks, decorative elements of a round shape
	Construction of the heel rounding; roundings that cannot be created using fillets
	Construction of parts with a break line
	Drawing Adjustment Tools
	Construction of rounding parts
	Construction of structural allowances and displacement of drawing lines by a given value
	Construction of perforations, decorative elements of footwear
	Building markup for blocks
	Grouping objects
	Ungroup objects for adjustment

Corrections of the drawings already available in the database based on the results of the “fitting” of gluing the soil model onto the block are carried out electronically. The content of the work will vary depending on the features of the model being developed. In case of correction of a drawing already in the database, it is necessary to ungroup it and perform operations, mainly using the “displacement” tools, while changing the height and latitude parameters of the structure. Figure 21, as an example, shows drawings of basic models for patients with cerebral palsy, developed in the AutoCAD program.

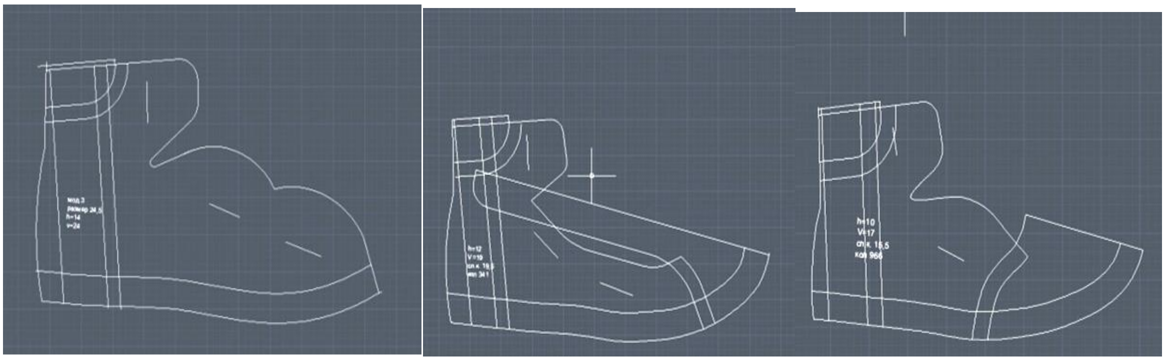


Figure 21. Shoe drawings developed in AutoCAD according to the proposed method

Designing shoes according to our proposed method speeds up the construction of drawings and allows you to create designs of both ultra and mass-customized shoes based on databases. In the manufacture of ultra-customized orthopedic shoes, there are cases when the girths of the right and left feet of the patient differ significantly from each other. At the same time, the fashion designer needs to create anatomically correct shoes and achieve the most aesthetic appearance of the product. In most cases, in the manufacture of shoes for patients with cerebral palsy, tibia blocks are used, since in order to create a shoe design with a high rehabilitation effect, it is necessary to tightly fit the shoe top blank to the shoe tube. In the event that the parameters of one of the feet correspond to the average, and for the manufacture of shoes there is already a ready-made drawing, then for a foot of increased fullness, an already prepared ground model must be applied to the most convex points of the heel and tufts and fixed (Figure 22). Having determined where there is not enough volume, it is necessary to make appropriate adjustments in the electronic soil. Important from the point of view of visual perception of shoes is the construction of a soft edging detail. Figure 23 shows a diagram of the distribution of consumer opinions regarding the size of the soft piping in finished shoes. Important from the point of view of visual perception of shoes is the construction of a soft edging detail. Figure 23 shows a diagram of the distribution of consumer opinions regarding the size of the soft piping in finished shoes. Important from the point of view of visual perception of shoes is the construction of a soft edging detail. Figure 23 shows a diagram of the distribution of consumer opinions regarding the size of the soft piping in finished shoes.

Figure 22. The position of gluing the primer model on the block

After analyzing the difference in girths in one half-pair, it was found that from a visual point of view, it is recommended to design soft edges of the same size relative to the back seam if the difference in girths does not exceed 21%. If the difference is more than 21%, it is recommended to increase the detail of the soft edging, leaving the same distance to the edge of the tibia. Examples of a drawing and a finished shoe model are shown in Figure 23. With an increase in girth, the front arch of the tibia decreases. It is important to consider the type of means of fixation on the foot. In the case of laces, it is appropriate to reduce the number of blocks in a half-pair of larger girth. At the same time, the distance from the extreme blocks to the edge of the berets should remain the same. When using Velcro tapes or belts with buckles, it is necessary to take into account the width of the belts in advance, relative to both half-pairs.

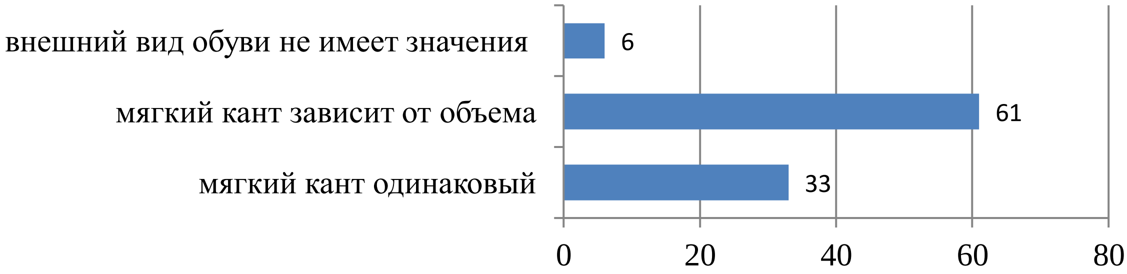
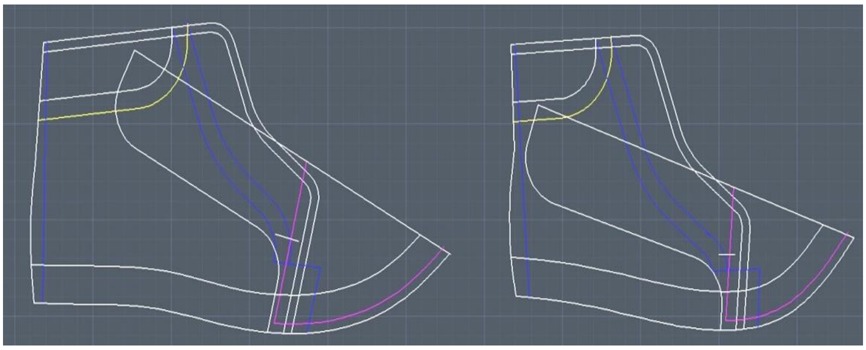


Figure 23 Distribution of consumer opinions regarding the size of soft piping in finished shoes



a

b

Figure 24. Examples of a drawing (a) and a finished shoe model (b) of ultra-customized shoes with different girth parameters

The reason for the different heights of shoes in a pair can be both a shortening of the limb, and significant deformations on only one of the feet. Shoes of different heights in a pair are prescribed by a doctor and agreed in advance with the patient. When designing such structures, it is necessary to strictly maintain the height and width parameters of the tibia part of the shoe. Examples of shoes with different heights of the tibia are shown in Figure 25.

Figure 25. Examples of ultra-customized shoes with different shin heights

With a difference in the height of the berets up to 3 cm, the number of fixing elements, such as buckles and Velcro tapes, is recommended to be left the same. In the case of fixation with laces, the number of blocks may differ. With a difference in the heights of the ankle boots over 3 centimeters, the number of buckles and Velcro tapes should be sufficient to securely fix the foot. From an aesthetic point of view, it is recommended to leave the height of the cut-off backs and the soft edge the same. If there is a cork in the intersole layer, the decorative elements of the foot fold assembly must be placed at an anatomically correct level, stretching the edges of the parts up and down along the vertical axis of the shoe. In the manufacture of ultra-customized orthopedic shoes, footprint length differences of up to 1 cm are common and are not difficult to design. In this case, adding length can be done evenly by lengthening the vamp and the back of the cuffs. With a difference in track length of up to 5 mm, with manual tightening of shoes, half-pairs can be made of the same size. From the point of view of design, it is interesting to create shoe designs with a difference in footprint length of more than 1 cm. As an example, Figure 26 shows a drawing of half-pairs of summer shoes with a difference in footprint length of 50 mm (220 and 270 mm, respectively).

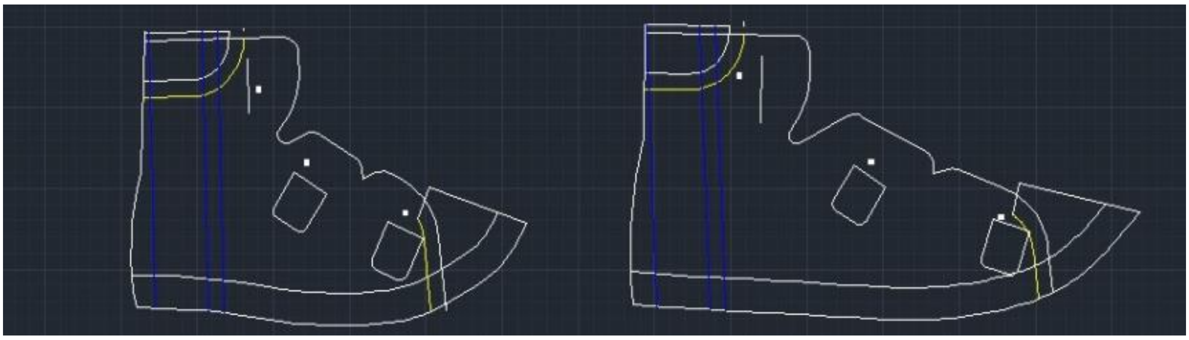


Figure 26. Shoe drawing with 50 mm footprint difference

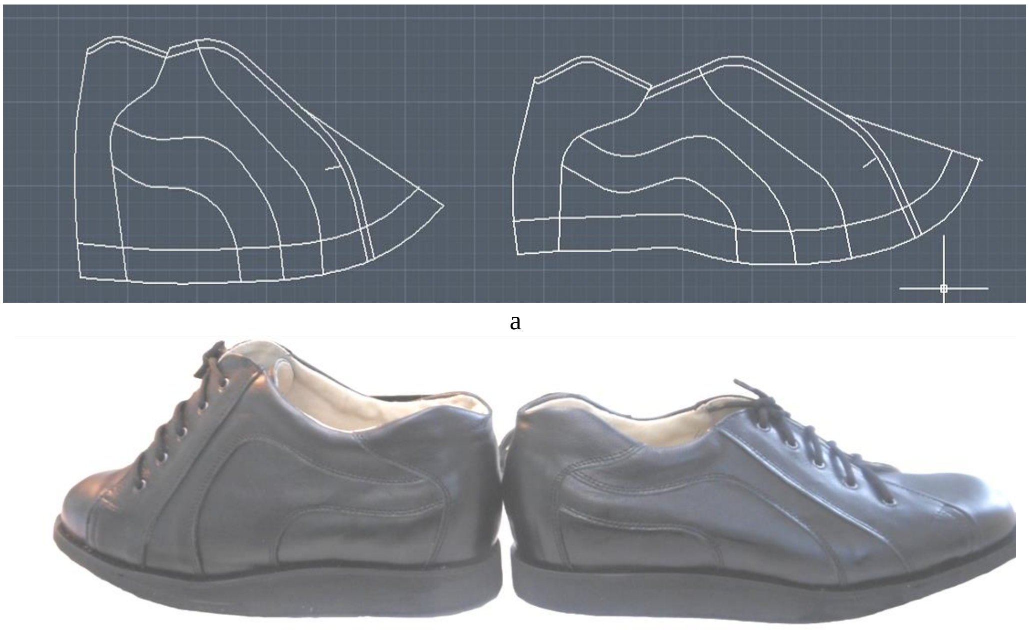
Figure 27. An example of an ultra-customized shoe with different footprint lengths and midsole

The construction of a soft edge is performed according to the method described above. When constructing vamps, it is necessary to calculate the length for both half-pairs of shoes. In a combination of different track lengths, if there is an insole layer in the toe part that compensates for the shortening of the lower limb, it is necessary to take into account the height of the latter to determine the length of the vamp (Figure 27).

The whole or composite tibia part expands evenly along the horizontal axis. In this case, the knot in the area of the fold of the foot must be built for each half-pair separately.

The length and height of the details that make up the beret are drawn by the fashion designer, based on the most harmonious visual perception of the future design. A drawing and a photograph of finished shoes with different track lengths are shown in Figure 27.

When distributing fixing elements (buckles and Velcro tapes), it is necessary to first analyze the patient's disease and the purpose of the frame parts of the shoe. Recommendations for the distribution of fixing elements are shown in Figure 29.



a

b

Figure 28. Drawing (a) and photograph (b) of finished shoes with different track lengths

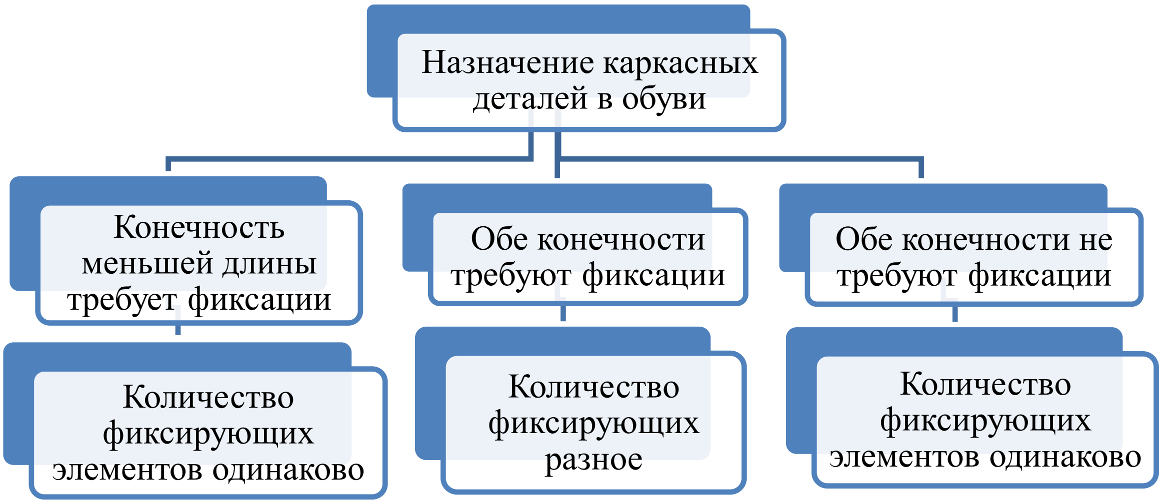


Figure 29. Recommendations for the distribution of fixing elements in shoes with different footprint lengths

Bilateral symmetrical shortening is manifested in a mismatch in the proportions of the limbs and torso. It occurs with achondroplasia (underdevelopment of long bones, leading to dwarfism) and other hereditary diseases. Anomalies in the development of the upper and lower extremities lead to asymmetric shortening. Unilateral shortening causes various diseases. The following types of it are distinguished: true (anatomical), relative (dislocation), apparent (projective), total (functional or clinical). With true shortening, the total length of the lower leg and thigh of one limb is less than the other. It occurs with organic bone lesions due to congenital deformity or certain diseases. With relative shortening, the ratios between limb segments are violated. This is due to the displacement of the articular ends of the bone due to congenital dislocations or intra-articular fractures. Relative shortening is characterized by the fact that one limb seems shorter than the other, but when measured, it turns out that the thighs and lower legs of the two legs are of the same length. Apparent (projective) shortening occurs due to forced flexion due to a fixed pathological setting in the spinal column or joints. As can be seen from Figure 28, the number of fixing elements directly depends on the purpose (functions) of the frame parts of the shoe. From the point of view of designing ultra-customized shoes, it is interesting to create designs of orthopedic shoes with shortening of the limbs. Shortening of one or two limbs by more than 2 cm is considered pathological. The classification of shortening of the lower extremities is shown in Figure 30. The reasons for this flexion: post-traumatic contracture, which appears most often due to the development of ankylosis. With projective shortening, as with relative shortening, the lengths of the legs seem to be different, but measurements show that they are the same. An example of such a defect can be scoliosis of the lumbar spine with a pelvic tilt. The total (functional or clinical) shortening is characterized by the fact that the patient has several types of limb shortening. Orthopedic shoes in most cases are prescribed only for unilateral true shortening, when, due to the intersole layer of the limb, the shorter leg is brought to the level of a healthy one. With projective shortening, as with relative shortening, the lengths of the legs seem to be different, but measurements show that they are the same. An example of such a defect can be scoliosis of the lumbar spine with a pelvic tilt. The total (functional or clinical) shortening is characterized by the fact that the patient has several types of limb shortening. Orthopedic shoes in most cases are prescribed only for unilateral true shortening, when, due to the intersole layer of the limb, the shorter leg is brought to the level of a healthy one. With projective shortening, as with relative shortening, the lengths of the legs seem to be different, but measurements show that they are the same. An example of such a defect can be scoliosis of the lumbar spine with a pelvic tilt. The total (functional or clinical) shortening is characterized by the fact that the patient has several types of limb shortening. Orthopedic shoes in most cases are prescribed only for unilateral true shortening, when, due to the intersole layer of the limb, the shorter leg is brought to the level of a healthy one. that the patient has several types of limb shortening. Orthopedic shoes in most cases are prescribed only for unilateral true shortening, when, due to the intersole layer of the limb, the shorter leg is brought to the level of a healthy one. that the patient has several types of limb shortening. Orthopedic shoes in most cases are prescribed only for unilateral true shortening, when, due to the intersole layer of the limb, the shorter leg is brought to the level of a healthy one.

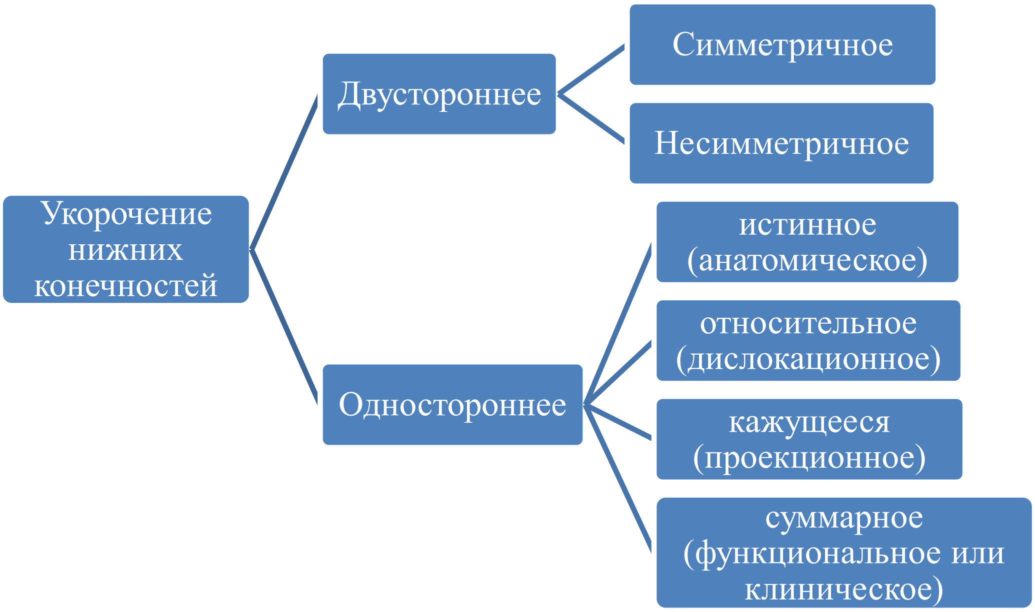


Figure 30. Classification of shortening of the lower limbs

a b

Figure 31 Drawing (a) and photograph (b) of finished shoes for limb shortening

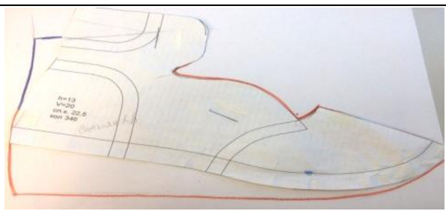
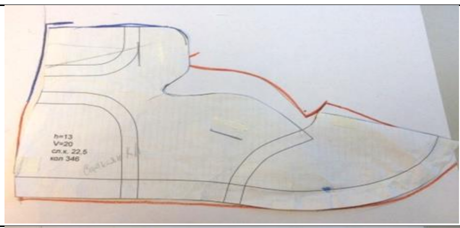
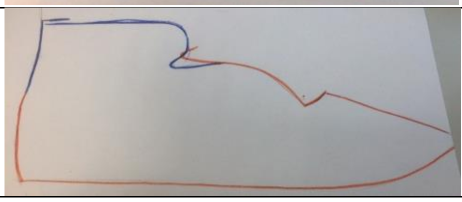
Figure 32. Shoe design with a seam on the vamp

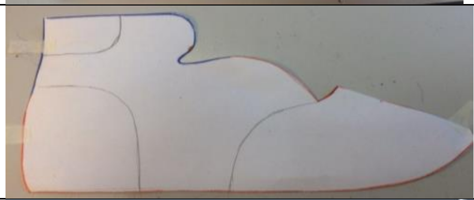
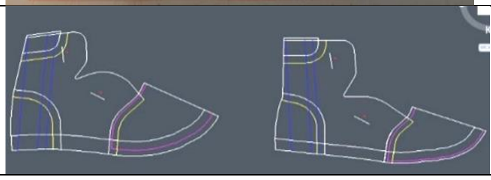
Figure 31 shows a drawing and a photograph of the finished product for a patient with a trace length of 195 mm and a shortening of 35 mm, to compensate for which plug 35 was used×20 mm.

With a cork in the toe part with a height of more than 3 centimeters, a seam can be provided for the most accurate fit of the workpiece on the block. An example of such a design is shown in Figure 32.

Based on the analysis of drawings, literature sources and the experience of employees working in this field, a methodology for designing shoes for shortening the lower limb has been developed. The description of the technique is presented in the form of table 32.

Table 17. Shoe design technique for limb shortening

Action Description	Illustration
Selection or construction of a soil model for a healthy (without shortening) leg (hereinafter referred to as the initial soil)	 
Fixing the gluing of the primer model in bundles and the heel on the block with a cork	
Measurement of future adjustments: cork allowance, back seam allowance, height adjustment, upper tibia angle adjustment	
Making adjustments to the drawing of a new model when fixing the gluing of the soil model in bundles and the heel	
Making adjustments to the drawing of a new model when fixing the initial soil relative to the horizon line	
Making adjustments to the ground model (in this case, reducing the height of the tibia at the place of fixation of the ankle joint)	

Trying on gluing the resulting workpiece onto the block	
Drawing lines of the drawing from the original soil with adjustments. (Performed manually or electronically)	
Model drawing development	

It can be seen from the diagram that with a probability of 87%, no adjustments were required to the resulting model. The remaining 13% required no more than 2 adjustments. This is due to the complexity of the designs being developed and the combination of limb shortening with other foot deformities. With a large number of drawings, it becomes necessary to structure them and create databases (DB), which are an effective means of presenting and storing information. Combining drawings into databases makes it easier to access and edit information about shoe models, which reduces the burden on employees and reduces the time required to find the right information. The software eliminates redundancy and duplication of information. To create a database, MS Access software was chosen, which is included in MS Office, available in most businesses. Thus, the creation of a database in this program does not require additional costs for the purchase of new software. The developed database has a button form that allows you to select a model for further printing and adding new drawings, viewing reference information. When you select a model from a previously proposed set, its brief description and image are displayed on the screen. The screen form of the windows of the MS Access program, in which the type and model of footwear is selected, is presented below. viewing help information.

When choosing a model from the proposed catalog, the required size and height-latitudinal parameters are specified. In the developed database, one shoe size of the selected model can have an almost unlimited number of drawings with different height-latitudinal parameters. When you select a drawing, you are transferred to the AutoCAD program. To avoid possible unplanned adjustments or deletions of the drawing, the changes made in the open window are not saved. It is possible to correct the drawing without further saving (in the event that not all elements of the file need to be printed), as well as to print the drawings. The developed database allows expansion by introducing new drawings at all stages: drawings with new height-latitudinal characteristics in the selected size; entering a new size in the selected model; adding a new model to the database. Such operations are performed by selecting the "Add model" command in the button form of the database. In addition to selecting and creating drawings, the developed database also includes directories that contain information necessary for the production of shoes with high technological and rehabilitation properties. The screen form of the window - with the ability to select reference information, as well as information related to lasts for the production of shoes.

Correction of impaired vital functions of the organism of children with clubfoot.

Most of the concerns parents have about flat feet and curvature of the legs are unfounded. Developmental options are numerous and with age, the foot takes on its normal shape. Only a competent orthopedist can determine if everything is normal with your child's legs. The best thing you can do for your child is to encourage him to move and avoid overeating. Remember that so-called corrective boots, liners, arch supports, braces, etc. are ineffective and will only make your child miserable. Let the magical power of time and growth do its work. What shoes should be worn? The model should be chosen of high quality, made of genuine leather. The ideal option is an elastic sole with good cushioning. From the unbending it is better to refuse a rigid base - it interferes with the work of muscles and movable joints of the joints when walking - they do not work, gradually relaxing. Advice to parents: when buying shoes for children, bend the sole. The front of the base should be pliable, and the back rigid. If you could not compress the base, look for another model. This is the advice of an orthopedic doctor (Figure 33):

Figure 33. Types of orthopedic shoes for children

The rubber sole for corrective footwear is ideal. The toe of orthopedic shoes should not create a lot of space for the toes, but should not exert pressure either. It is forbidden to purchase corrective shoes “for growth”: shoes should tightly cover the foot. A closed heel is a must, including for summer models. Open sandals lead to the fact that when walking, the heel begins to move, “fidget”, increasing the deformation of the joints. With the correct setting of the heel, the curvature of children's legs is absent. Overweight children should wear closed-toe sandals. Proper children's shoes. We destroy stereotypes. We ask questions:

What should be the right children's shoes?

Why do children develop flat feet, and how to avoid it?

Is it true that the first shoes for the baby should be "orthopedic"?

Should a child wear shoes at home?

What should be indoor shoes for a child?

Do children's shoes have to have an arch support?

The topic is burning: very often orthopedic shoes are prescribed for crumbs, and often orthopedic doctors contradict each other. One puts a child at 2 years old with flat feet and directs them to get orthopedic shoes, the other says that, they say, your baby is absolutely healthy, and advises mom to drink motherwort, and the child to run, jump and enjoy a carefree childhood. One says that children's shoes must have an arch support, the other categorically disagrees with this. How is a child's foot formed? We have already considered in the message one what a foot is. So, the first thing to understand: a child is born with a flat foot. Remember, dear parents, what the feet of your children looked like when they didn’t even walk under the table (Figure 34). As you can see, the place that will later become the longitudinal arch is now filled with fat. And it is right. After all, the vault is what? This is a spring that springs up when we walk to absorb shock loads and not “bomb” the joints of the legs and spine. Why would such a child need a spring? Because he doesn't walk yet. Is it logical?

Figure 34. General view of the child's foot

Recall another important point: the arched shape of the vaults is supported by the muscles of the lower leg and foot. But the muscles are not yet developed, because our baby does not yet walk, run, or jump. And when he gets on his feet and takes his first steps, the fat pad of his feet is very useful to him:

firstly, it increases the area of support and increases the stability of our child, so that he understands that walking is good! And you will see more, and you will feel more, and you don't have to call your mother, you can walk to her. First, along the wall, then in short dashes, and now "the bull is walking, swinging";

secondly, plantar fat is needed for cushioning, while there is no full-fledged spring yet.

Such a voluminous fatty pad remains in children up to 3 years of age, and then begins to gradually dissolve. By the age of 5, a longitudinal arch emerges, and at 7-10 years old we already see a foot that is very similar to an adult. And the complete formation of the human foot ends at about 20 - 21 years old, for girls - 2 - 3 years earlier. This means that by this age, ossification of all cartilaginous structures of the foot occurs. But while the baby begins to walk confidently, he will go through a difficult school of balancing act. As soon as he gets up on his feet, he rests more on the outer arches of the foot. This is called "varus stopping." It happens in children up to about 1.5 years (Figure 35). As the baby learns to walk, he tries to keep his balance by spreading his legs wide. It is precisely the same fat pad that helps him maintain balance. about which we spoke above, and on which he begins to rely. It turns out some blockage of the stop inside. This is called hallux valgus. Here's what it looks like (Figure 36).

Figure 35. Characteristics of the outer arch of the child's foot

Figure 36. General view of a child's clubfoot

This condition is noted, as a rule, in 2 - 4 years. Further, as the musculoskeletal apparatus of the feet strengthens, the shape of the legs usually levels out: the lower leg, knees and thigh line up in one line. And if normally the angle of valgus deviation of the calcaneus at 3 years is 5-10, then by 7 years it is 0-2. norm option.

So if your two or three year old has been diagnosed with flat feet, know that everything is going according to plan and there is nothing to worry about. And there is absolutely no need to run for orthopedic shoes. Well, what did the doctor prescribe? Are you a mother or what? It is better to concentrate your attention on strengthening the muscles of the feet and legs of your child, and you will all be happy: both parents, and the baby, and his feet. Let's go back to the past. In the 60s of the last century, employees of the Leningrad Institute of Prosthetics. Albrecht conducted a study in which about 5,000 children participated. They assessed the "maturation" of the arches of the foot. And look what happened: at 2 years old, flat feet were detected in 97.6% of children, and at 9 years old, it remained only in 4% of those observed. Of course, if we conduct this study in our days, the indicators will be more deplorable, and if we remove all computers, gadgets, phones now, what will children do? What about adults? I wonder if jump ropes are on sale now, or is it already a rarity? Do modern children know the game "dodgeball"? Do they play badminton? We did not sit at home, especially on the weekend. We ran and jumped all the time, so the diagnosis of “pathological abnormalities” was not stored in our childhood memory. Pathological deviation - clubfoot in children (Figures 37 - 38).

Figure 37. Characteristics of the measurement of feet with pathological deviations

Figure 38 Features of the selection of orthopedic shoes for feet with pathological deviations

child's foot

The foot is formed by 26 bones, not counting the sesamoid bones, connected to each other by means of joints and ligaments. The latter give the foot a rather complex shape, resembling a spiral or a propeller blade and providing mobility in three planes. Maintaining the shape and performance of the functions of the foot contributes to the activity of 42 muscles of the foot and calf muscles (Figure 39).

The feet undergo changes throughout a person's life, but the formation of the arches of the feet is most intensive in the first 7 years. Further, the periods of rapid growth of the child during the school years, periods of hormonal changes, will be critical for maintaining the shape and function of the feet. The foot in the human body performs three biomechanical functions: spring, balancing and pushing. With flat feet, all functions of the foot suffer. Spring function - softening shocks when walking, running, jumping. It is possible due to the ability of the foot to elastically spread under the action of a load, followed by the acquisition of its original shape.

Figure 39. Skeleton of a child's foot

Studies have shown that when walking fast in shoes with a hard heel on a parquet floor, accelerations in the heel area reach a value that is 30 times greater than the acceleration due to gravity (g). In people with healthy feet on the shins, the acceleration is 5-6 g, and only 1 g reaches the head. With flat feet, shocks are more sharply transmitted to the joints of the lower extremities, the spine, and internal organs, which contributes to the deterioration of the conditions for their functioning, microtraumatization, and displacements. Balancing function - regulation of a person's posture during movements. It is performed due to the possibility of movement in the joints of the foot in three planes and the abundance of receptors in the bag-ligamentous apparatus. A healthy foot sculpturally covers the irregularities of the support. A person feels the area through which he passes. With flat feet, the position of the bones and joints changes, the ligamentous apparatus is deformed. As a result, children suffer from coordination of movements, stability. The jogging function is the message of acceleration to the human body during movements. This is the most difficult function of the foot, since it uses both the spring and the ability to balance. The weakening of this function is most clearly manifested when running, jumping (Figures 40-41).

Figure 40. Orthopedic shoes for summer

Since ancient times, another function of the foot has been known that is not directly related to biomechanics. The foot is an area rich in nerve receptors and is the "energy window" of the body. It is known that the cooling of the feet causes reflex vasoconstriction of the mucous membrane of the upper respiratory tract, which is most pronounced in a non-tempered person. In traditional oriental medicine, it is believed that through the foot you can access any part of the body. Treatment from mother nature is the safest, cheapest and most effective. Today we should voice such a problem as clubfoot. This is a congenital pathology, so parents, after traumatic orthopedic manipulations that barely improved the condition of their baby, give up. However, there are many alternative techniques that can stop the progression of pathology. These include osteopathic treatment. Clubfoot (intoeing - fingers inside) is a term not known to official medicine (unlike clubfoot).

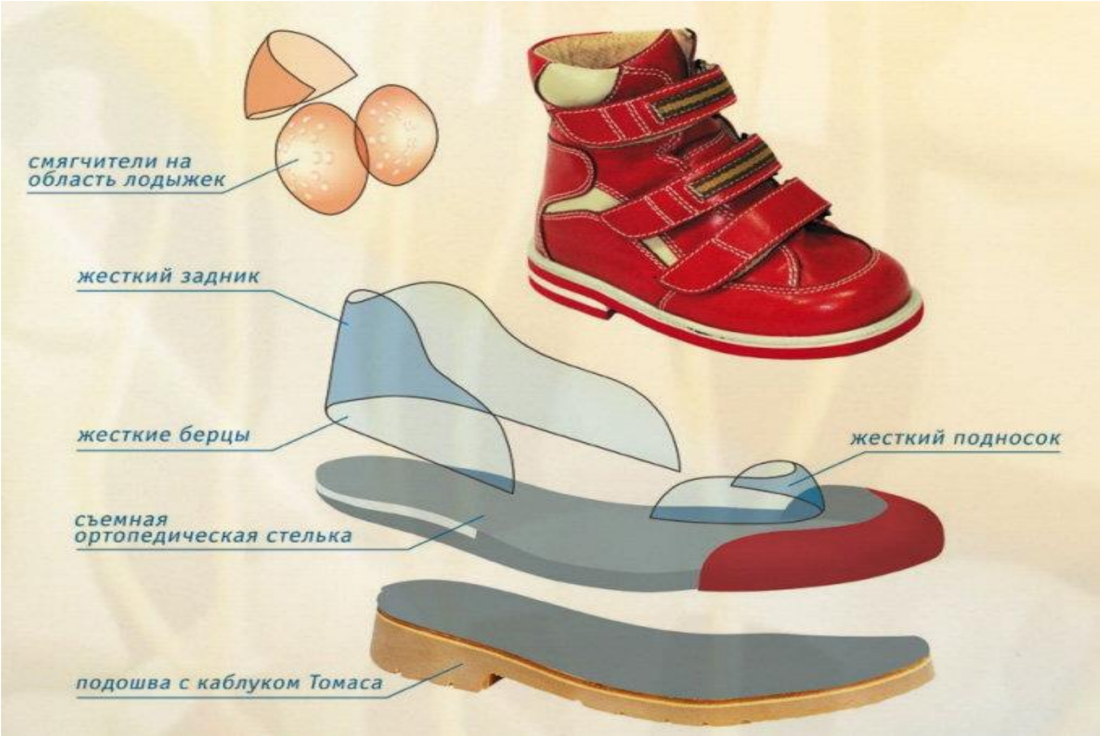


Figure 41. Features of orthopedic shoes for summer

This term was most likely invented by the parents themselves at the suggestion of illiterate doctors. Under the clubfoot, in most cases, parents mean the child walking with the feet turned toes inward. Since there is no official name for this condition in Russian medicine, for brevity we will use the English version of intoing (intoeing). Intoing is a very common occurrence in childhood that usually goes away as we get older. There are three causes of intoing that the podiatrist can determine during the examination.(figure 42):

curvature of the foot;

torsion (twisting) of the bones of the lower leg;

torsion of the femur.

Curvature of the foot is caused by the position of the fetus inside the uterus(figure 43). Most positional curvatures of the feet go away on their own, without treatment, during the first months of a child's life. Although in some cases, improvement in the shape of the foot may continue until the age of three. In rare cases, when the curvature of the foot is very pronounced, slowly disappears, the foot is stiff, it is necessary to apply corrective plaster bandages. Special boots do not lead to improvement in this situation.

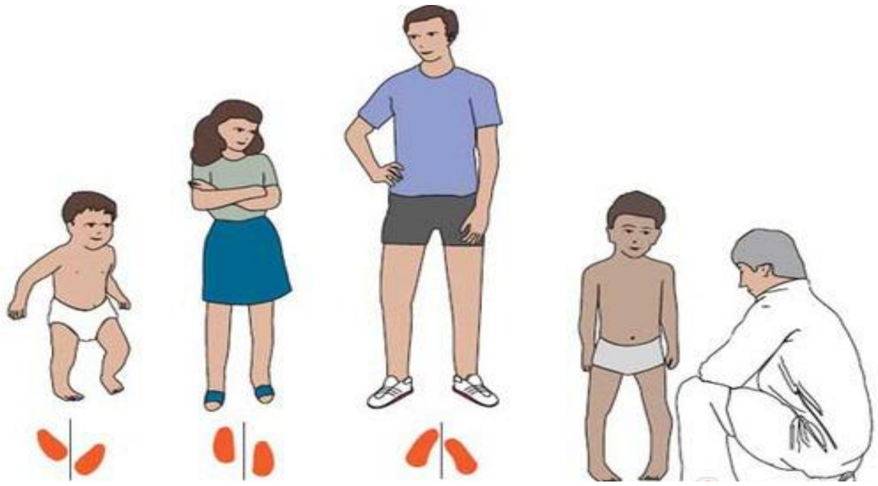


Figure 42. The influence of the age of the child on the characteristics of his pathological abnormalities

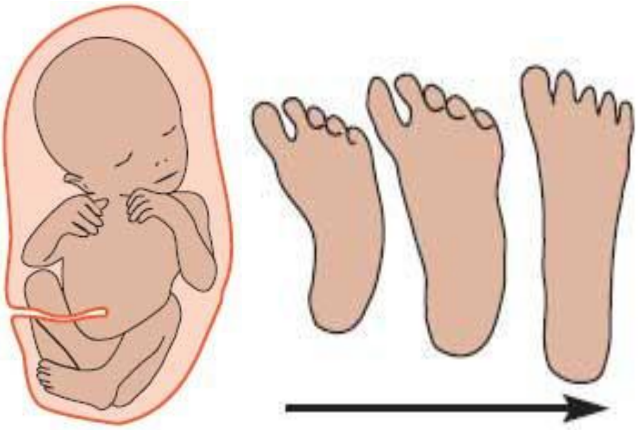


Figure 43. Causes of the formation of clubfoot in the fetus in the womb

Torsion of the lower leg is the twisting of the bones of the lower leg, in this case medially, along its axis. This is a normal variant and is very common in newborns and young children. Orthoses, special exercises, brace or orthopedic shoes are not able to correct the twisting of the bones and, in fact, can be harmful. In most children, the bones "straighten" on their own, without any treatment, in the first years of life. Hip torsion is the twisting of the femur, causing internal rotation (rotation) of the leg and intoing. Hip torsion is usually the cause of walking with the feet turned inward in children aged 5 to 6 years. For most children, the situation returns to normal by the age of 10. Shoe inserts, special orthopedic boots or braces are not able to reduce hip twist and correct gait.

Curvature of the legs (O-shaped and X-shaped legs).

During normal growth, a child's legs can take on a variety of shapes. With the onset of walking, O-shaped legs are very often formed, which straighten on their own by two years. In some children, by the age of 1.5 - 2 years, X-shaped legs are formed (knocking knees, knocked knees, in English literature). The vast majority of X- and O-shaped legs straighten on their own by the age of 5-6 years. Shoe inserts, special orthopedic shoes and exercises do not affect the process of leg growth in any way, but they can cause discomfort to the child and make him feel sick. Only a competent orthopedist can decide whether there are any violations in the growth of the child's legs or not. The doctor may suspect a pathology if the deformity of the legs is severe, expressed mainly on one side or the curvature of the legs can be seen in other family members, especially if most of the close relatives are small in stature. Barefoot people have the best feet! Your child needs soft, flexible shoes that allow maximum freedom for normal foot development. It is better to choose shoes a little looser. Rigid, "orthopedic" shoes are not suitable for the feet, because they restrict the movements that are necessary for developing strength and flexibility of the foot. A child's feet need protection from cold and sharp objects, as well as freedom of movement. Falling children can cause injury. A flat sole that doesn't stick to the floor and doesn't slip the best. which gives maximum freedom for the normal development of the foot.

What lies behind the diagnosis of clubfoot?

Clubfoot is a congenital anomaly of the anatomical structure of the joints of the foot. The defect affects and affects the functioning of the bones and muscles of the lower leg, ligaments and tendons. Incorrect anatomy of the body structure is formed in the early stages of pregnancy. Doctors have not yet fully established the causes of this violation. This completely deprives medicine of the ability to prevent the formation of clubfoot, and reduces the effectiveness of treatment of the legs after the birth of a baby with this pathology. Outwardly, the clubfoot looks like an unusual inversion of the foot inward and slightly down. With such a structure, it is very difficult for a little man to learn to walk. It is impossible to fully step on the foot in this position (Figure 44). Types of clubfoot. Congenital clubfoot can be of varying severity, have its own signs, so in medicine there is the following division of pathology into types:

typical (still characterized as primary) clubfoot of a mild form;

typical clubfoot affecting soft tissues;

typical bone-shaped clubfoot;

atypical (referred to as secondary) neurogenic clubfoot;

atypical clubfoot of the amniotic form;

atypical clubfoot caused by congenital deformity of the joints;

secondary clubfoot caused by underdevelopment of the tibia.

Since clubfoot is a congenital disease, its occurrence is influenced by adverse factors that affect the fetus in the womb. The reasons for the formation of clubfoot are as follows:

incorrect position of the fetus, as a result of which the walls of the uterus put pressure on the foot, and an abnormal anatomical structure of the foot develops;

the fetus has an incorrect laying and development of muscles, ligaments, joints, which leads to foot deformity;

toxic effects on the child's body of certain medicinal components that the expectant mother could take in the early stages of pregnancy;

insufficient intake of the mother's body and, as a result, a lack of vitamins and important trace elements for the fetus (Figure 44).

Treatment of clubfoot by methods of classical medicine.

The most common method of eliminating congenital clubfoot is gypsum. Plaster boots are put on the baby's legs, fixing the previously deployed foot in the correct position. Mild clubfoot is corrected with soft bandages. In general, the method is similar to plastering (Figures 45 - 46).

Removable devices - orthoses - are used for the treatment of clubfoot. It can be special fixators for the foot, and simple insoles for shoes. Also, children are prescribed additional massage and therapeutic exercises. It is important for parents to remember that there comes a time when clubfoot is no longer amenable to correction, and it will no longer be possible to help the child. Therefore, treatment should begin from the first days after birth (Figure 47).

Figure 44. Features of clubfoot in children

Figure 45. The effectiveness of the "Family" program to reduce pathologies of the fetus of a child in the womb

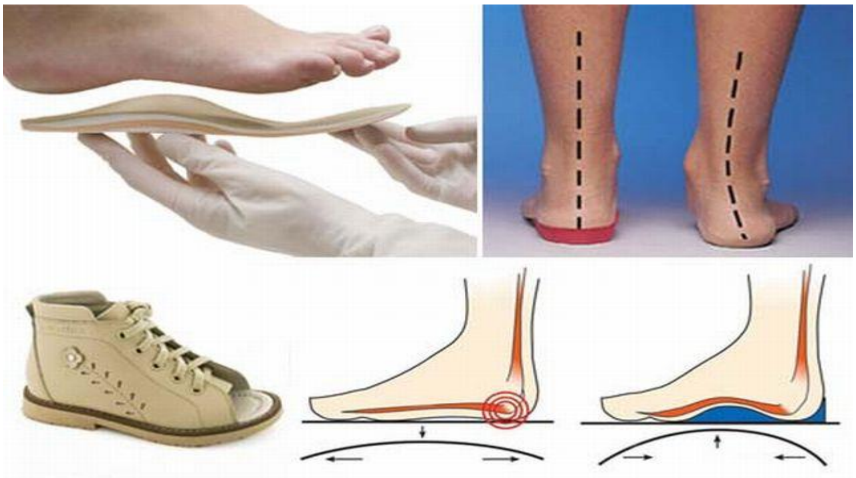


Figure 46. Preparation for the treatment of clubfoot

Figure 47. Features of fitting an orthopedic insole for clubfoot feet

Figure 48. Types of massage to correct clubfoot

Osteopathic practices in the fight against clubfoot.

The osteopathic doctor eliminates the clubfoot defect by giving the bones and joints an anatomically correct direction. In this case, the ligamentous apparatus comes into the desired position. Manipulations with the child's leg are carried out carefully and delicately. During the first week after therapy, the mobile joints will return to the anatomically correct course. After this time, the result will become obvious. Treatment with an osteopath can be started at any age, but the correction of a defect in the first days of life is the key to the proper development of your child. The sooner treatment is started, the higher the chance that the child will get rid of clubfoot, be able to actively play and run, and maybe even make a career as an athlete.

Clubfoot or clubfoot is a deformity of the arch of the foot, as a result of which it changes its location and thereby causes a lot of inconvenience to a person, both in terms of pain when walking, and in aesthetic terms. Most parents are interested in why clubfoot develops in childhood. One child in a thousand is born with a clubfoot. That is, with one or two feet turned inward. If you leave everything as it is, the child will not only get on his feet later than his peers, he will get up completely different from them. With clubfoot, the heel is pulled up, and the toes are turned inward. The child steps on the outside of the foot. And if he goes like this, the foot will deform even more, and behind it - the whole leg. It's uncomfortable, and most importantly, it hurts. The person becomes disabled. Fortunately, clubfoot is treatable. There are many ways(figure 64)baby's supple feet bounce back in just a couple of months. One of the first in Russia to master it was the Yaroslavl orthopedist Maxim Vavilov. Now he heads the Russian Ponseti Association, and in the Yaroslavl region there are virtually no clubfoot children older than six months. Children from all over Russia, Belarus and Kazakhstan go to M. Vavilov and his colleagues at the Constanta clinic for treatment. Including - within the framework of a joint program with Rusfond.

Figure 49. Examination by an orthopedic doctor of a child after plastering

A description of how this happens is given below:

Clinic "Constanta" occupies the entrance of a residential five-story building. Maxim Vavilov, a military-minded man with a short haircut, greets us at the entrance and immediately hurries to the office of his colleagues Ilya Gromov and Ekaterina Solovieva: the operation is in half an hour. Without having time to figure anything out, we are already eating with them in the elevator to the fifth floor, to a small children's section with a playground in the corridor. M. Vavilov looks into one, the other chamber. And confidently enters the third. The girl smiles shyly. Mom explains that Eva had a Ponseti cast as a baby and wore medical shoes - brace until she was three years old. These are such boots with a crossbar - people on the street confuse them with a skateboard, although there are no wheels. As soon as the brace was removed, the left foot began to deform. A more detailed description of the brace is given below.

“We didn’t know that brace should be worn (at least sleep in them) until the age of five or six,” Mom explains. “Our orthopedist suggested a major operation that leads to relapses. We decided to go here, to the specialists. And here Eva is here for two weeks in a cast - we are pulling the ligaments, and today there will be a small operation.

The anesthetist comes to Eva, and the orthopedists and I rush to follow the mobile Vavilov back into the elevator - now to the third floor, to the operating room. Giving us sterile trousers and a robe, M Vavilov explains:

– Clubfoot has always been treated with casts and surgery, but over time the methods have become more humane (Figure 49). Even 15 years ago, we performed another operation on clubfoot. They cut the skin around the ankles, then cut the tendons and muscles, releasing the joint. They fixed it with plaster and waited until all the tissues were healed. All those operated on had ugly scars. Most of them have pain and an inactive foot. A third returned to the operating table with a relapse. Now, after plastering according to the Ponseti method, 98% of patients live without relapses and without operations. For the rest, relapses usually occur due to errors in wearing braces.

While we were changing clothes, the little Magpie had already fallen asleep on the operating table. There we see not even a sleeping girl, but her leg: the rest is hidden by disposable green diapers. They put a tourniquet on the girl's thigh to stop the blood from flowing. M. Vavilov wipes his leg with a large swab soaked in iodine. The leg turns yellow. The doctor wraps the leg from the toes to the knee with an elastic bandage and holds it vertically for a minute to completely bleed it. Unwound, puts on the table. The yellowish leg now looks like a silicone trainer.

After making the first tiny incision above the heel, the doctor literally cuts the Achilles tendon in seconds to lengthen it. This micro-operation - achillotomy - is not at all spectacular. For many clubfoot, this operation is done under local anesthesia, almost at the reception with parents.

Then the doctor makes two of the same bloodless incisions - longer, along the top of the foot. He takes a needle with a thick blue thread and begins to literally alter the tendons, similar to white braid. Like Dr. Aibolit in the pictures with a bunny. He hooks a tendon braid with a needle in one incision and fastens the thread in it with a couple of stitches, as they teach at school in labor lessons. Then he drags the tape under the skin to another incision and pulls it out. The foot stretches after the braid and immediately rises as it should: at a right angle to the lower leg. The orthopedist sews this tendon in a new place. And then famously pierces the foot with a needle through and ties a purl knot in the center of the sole with a thread. Everything takes no more than 15 minutes. It remains to sew up the incisions with absorbable threads and plaster the leg for a couple of months (Figure 50).

In difficult cases, like in the case of a six-year-old ward of Rusfond, such an operation is indispensable. The girl was born with several leg pathologies at once, including clubfoot. She also has, for example, three toes on each foot. All this was found in the hospital.

- Clubfoot is visible on ultrasound as early as the twentieth week of pregnancy, - says M. Vavilov. – However, in Russia in 90% of cases it turns out to be a surprise after birth. But it is better for parents to know in advance what problem they will face, to find specialists and start treatment in the first month of life, so that the legs immediately develop correctly.

Figure 50. Examination of the child's foot by an orthopedist after surgery

The doctors offered the girl's parents to observe her from half a year. But they took the girl to Moscow, where she was cast according to the Ponseti method. At a year and a half, the big-eyed blonde with black eyebrows was already walking herself, in braces, which she wore around the clock until she was five years old. Then her left foot was deformed, and not in the most usual way - due to a defect in the formation of the ankle joint. In addition, the leg has become shorter than the right. It became difficult for the girl to walk. An orthopedist from the Filatov hospital recommended that M. Vavilov be consulted.

- Ten years ago, says M. Vavilov, he treated clubfoot, and then it turned out that different people come on the basis of clubfoot: with problems of the lower leg, knee, and hip joints. - And now he prefers to treat the lower limb - it's more effective. They can treat the girl in stages. Now - just straighten the clubfoot and send home. After two or three months - remove the knitting needles and let her walk for six months so that she returns to the hospital with a short straight leg. And only then put the Ilizarov apparatus to stretch the bone. But we can do all this in one anesthesia, so that in six to seven months the Girl walks with full support on the corrected leg in order to beat the time. More precisely, try to beat the time. This operation - more precisely, several operations in a row - drags on for hours. Now the orthopedist looks like a bloodthirsty barmaley. He not only has to cut a lot - both skin, and tendons, and muscles - but also chip off pieces of a too wide fibula. Otherwise, the foot simply does not rise to the lower leg. Doctors exchange short business remarks. But they look wild: one doctor holds a child's leg, and the second, with a chisel and a hammer, hammers a bone and throws large fragments into a jar. And then he inserts a knitting needle into the drill, screwing it into a living leg with a buzzing sound and cutting off the ends with wire cutters. And so four knitting needles in a row - along and across the foot. Yes, he jokes, cheering up tired colleagues. When the nurse hands Vavilov scissors with very thick blades, he bats his long eyelashes, asking her? Do you work for the Inquisition?

- This is from a set of plastic surgeons, - she answers to the general joy (Figure 51).

Figure 51. Traumatologist-orthopedist M. Vavilov is preparing for surgery

But the curved foot, which at first seemed to us completely different from the usual one, with a huge callus on the side, as if with a second heel, looks good after an hour. Except for the tips of the spokes sticking out of it and the slowly flowing blood. And the doctors still have to sew everything up. And then put the Ilizarov apparatus, which is also fastened with knitting needles in the bone tissue.

– Are you waiting for breakthroughs in orthopedics? I often ask M Vavilov. - Anything more humane than the spokes and the Ilizarov apparatus?

“No, no,” he replies. - In the spring, he went to Tel Aviv for a conference: he didn’t see anything new, they still do the same in good Russian centers. The main breakthrough now can only be in reducing the cost of expensive metal structures. This will change many lives (Figure 52).

In Russia, there are already many orthopedic doctors practicing modern methods of treatment, but you can hardly find them in regional clinics.

- In the clinic, a practicing doctor complains that he has neither a nurse nor a plaster room. “And even if there was, she still wouldn’t use the Ponseti method: too little time and money are allocated for plastering. Today they can only observe children with clubfoot, since out of 13 thousand they have only two of them.

So the parents of clubfoot have to spend once or twice a year on brace, which cost from 10 thousand rubles, and after five years - on a special stand, on which you need to stand every day for half an hour. And also a doctor. After all, even in a good situation, you need specialist control over a child up to ten years old.

Figure 52. Fragment of the operation in the clinic of M. Vavilov

The course of treatment of clubfoot according to the Ponseti method.

Treatment includes three stages. The first stage is the correction of the deformity with plaster bandages. Treatment according to the Ponseti method consists in a weekly change of plaster casts, while a phased plaster correction is performed with the removal of the foot from the deformity position to the correction position 10-15 degrees at a time, per week.

As a rule, a complete correction of a deformed foot, even in difficult situations, is achieved in 5-6 changes of plaster casts.

During the first cast, the cavus and adduction are corrected. The foot remains in the same plantar flexion. At the second, third and fourth casting, adduction and varus are corrected. The first element of the method is to correct the cavus of the foot by properly aligning the front of the foot with the back.

Figure 53. First cast of a child's foot

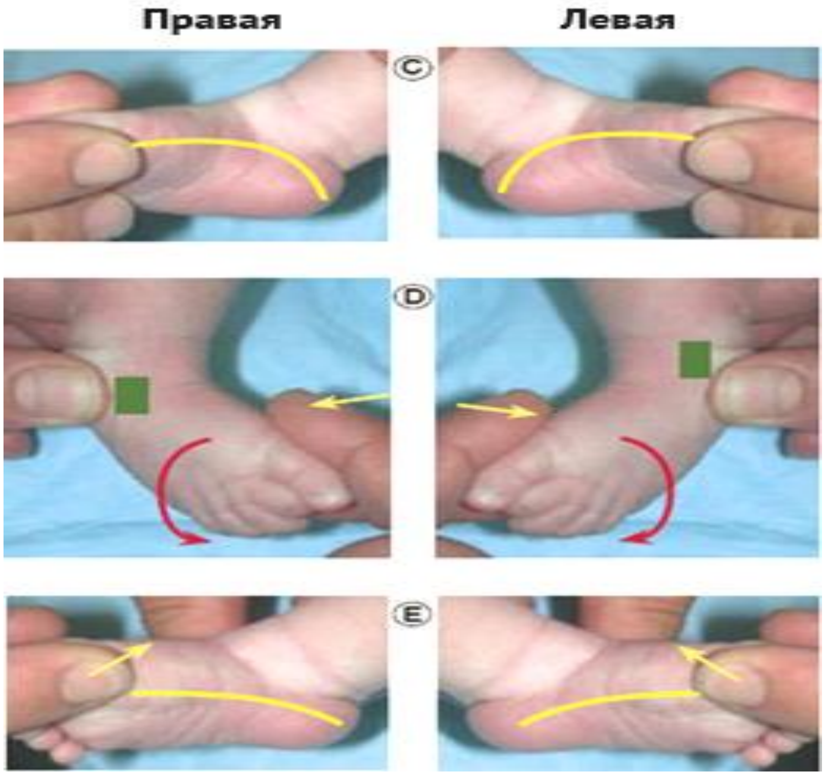


Figure 54. Cavus of the foot

The cavus of the foot (high arch (see Figure 54, C, yellow arch) is formed due to the pronation of the forefoot in relation to the hindfoot. In newborns, the cavus of the foot is always elastic and requires only supination of the forefoot to normalize the longitudinal arch (see Figure 52, D and E).

Further correction will consist of abducting the foot under the fixed head of the talus. Note that the correction of all components of the clubfoot, except for the equinus, is carried out simultaneously. For correction, you first need to correctly determine the location of the head of the talus, it will be the fulcrum during the correction. Palpate the ankles with the thumb and forefinger of the hand - Figure 55, A, and with the other hand - Figure 55, B - fix the metatarsus and toes. Move thumb and forefinger - Figure 52, A - forward to palpate the head of the talus (indicated in red), which is located anterior to the fork of the ankle joint. Since the scaphoid (yellow) is displaced medially, and the tuberosity of this bone is practically in contact with the medial malleolus, you can palpate the convex lateral part of the head of the talus (red), covered only by skin and located in front of the lateral malleolus. And the anterior part of the calcaneus (indicated in blue) will be palpated below the head of the talus. As you move the forefoot outward in supination with your hand - Figure 55B, you will feel the movement of the navicular bone in front of the head of the talus and the movement of the calcaneus outward under the head of the talus (Figure 55).

Next, the talus is stabilized. Place your thumb on the head of the talus (see Figure 55, A, this is indicated by yellow arrows). Stabilization of the talus provides a pivot point around which the foot rotates outward. The index finger of the hand holding the head of the talus should be behind the outer malleolus. This further stabilizes the ankle joint with maximum abduction and avoids the tendency of the posterior calcaneofibular ligament to move the fibula posteriorly.

Further abduction of the supinated foot (see Figure 55, A) with stabilization by thumb pressure on the head of the talus (as indicated by the yellow arrow) continues until it becomes uncomfortable for the child.

With light pressure, hold the correction for about 60 seconds, then release. As the clubfoot is corrected, lateral mobility of the navicular and anterior calcaneus increases (see Figure 55, B). After the 4th or 5th cast, a complete correction becomes possible. For particularly rigid feet, more casts are needed.

During the second, third and fourth casts, the varus and adduction of the foot are completely corrected. The distance between the tuberosity of the navicular bone and the medial malleolus, determined by palpation, tells us about the degree of correction. When the clubfoot is corrected, this distance is about 1.5 to 2 cm, with the navicular covering the anterior surface of the head of the talus. Improvements are observed with each plastering.

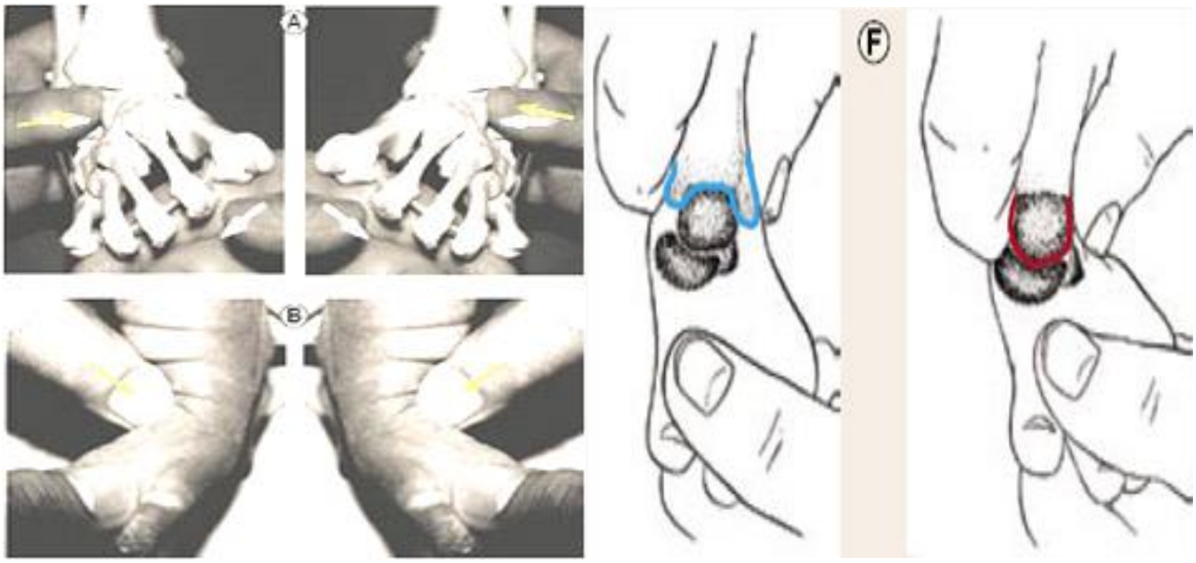


Figure 55. Polpation of the ankles

The equinus, or plantar flexion, is gradually corrected with the correction of varus and adduction. This partial correction is due to dorsiflexion of the calcaneus as it is retracted under the talus. Until heel varus is corrected, no direct effort should be made to correct plantar flexion.

Complete correction of the cavus, adduction of the foot and heel varus, partial correction of the equinus is not enough, a tenotomy of the Achilles tendon is necessary. With very flexible feet, the equinus can be corrected with an additional cast without Achilles. However, if in doubt, surgery is indicated.

The second stage is achillotomy, a very important part of the treatment (Figure 56). In clubfoot, the Achilles tendon is always shortened, so most children need to lengthen it. The Ponseti method involves the use of the most gentle method of lengthening it - a closed achillotomy. In most cases, subcutaneous transection of the Achilles tendon is performed to complete the correction of the equinus - plantar flexion of the foot. After the operation, the last plaster is applied for a period of 3-4 weeks. This period is sufficient for the Achilles tendon to heal to the length required for correction.

On average, the total period of treatment in plaster is 1.5 - 2 months.

Figure 56. Fragment of the use of a sparing method of lengthening - closed achillotomy

The third stage: fixing the result. For this, specially designed tires are used (brace) to avoid deformation return. To avoid relapse, you need to wear braces strictly according to the regimen prescribed by the orthopedic doctor. A cured child should undergo regular examinations until the age of 2 to 5 years.

The effectiveness of the treatment of severe clubfoot according to the Ponseti method in children reaches 95%. But relapses occur after treatment by this method. The most common reason relapse is non-compliance with the mode of being in brace and poor quality of fixation in brace after achillotomy. According to University of Iowa orthopedists, relapse occurs in only 6% of families who carefully follow the doctor's instructions, and in more than 80% of families who are inattentive to the doctor's recommendations. Among the causes of recurrence, there may be an imbalance in the muscles of the lower leg, in particular the features of the attachment of the tendon of the anterior tibial muscle. Therefore, in order to avoid relapse, parents should follow the recommendations of the attending physician. After having completed a course of correction with manipulations and plaster casts, the attending physician begins to work with brace, adjusting the angular characteristics:

the distance from the inner edge of the heel of one shoe to the inner edge of the heel of the other shoe is equal to the distance from one shoulder to the other;

for permanent use, the brace is usually adjusted in this way: for a clubfoot foot, the abduction is 70 degrees, for a healthy one - 40 degrees;

with bilateral clubfoot, the abduction is 70 degrees on both sides;

for a clubfoot foot, dorsiflexion (flexion of the foot at the ankle joint) is usually 5 to 10 degrees. As a rule, this position corresponds to the position of the foot in the last cast. Ankle flexion is not necessary for a healthy foot.

Schemes for the use of shoes for clubfoot for children under 6 months and after have differences. Let's consider them in more detail in tables 3.23 - 3.24.

At first, the child wears brace 23 hours a day, this period lasts 3-4 months. Further, under the supervision of a doctor, the wearing time is gradually reduced to 18 hours, depending on the condition of the feet. At the same time, brace should be used for all types of sleep - this protects the child's psyche. A habit is instilled, and the child understands that you need to wear braces every day, without being indignant about the fact that “today I slept without braces, and tomorrow they need to be put on again.” After reaching the age of 2, a child visiting the garden, in order not to differ from his peers, can walk in the garden without clamps. However, braces are mandatory at home.

Babies don't feel well during the first time they wear braces, they don't sleep well and cry more than usual. The limited freedom of movement, the fragility of the skin after plastering negatively affect their well-being. All this should not be a cause for your concern. At first, children can take analgesics, sedatives. The child will get used to the new shoes after two days. It is very important that parents do not give up and wait until the child gets used to it. If there is severe redness, you need to consult your doctor. In addition, a doctor should be consulted if the child sleeps restlessly in brace for more than 3 nights.

Corrective products for correcting clubfoot of children's feet

Braces are a bar-fixator for abducting the foot with shoes, special shoes for clubfoot. They can only be used after the clubfoot has been completely corrected by manipulation and plaster casts (Figures 73-800).

Conclusion

Based on research to determine consumer preferences, it has been established that currently sold children's shoes with preventive properties have some drawbacks regarding both materials and structural and external features.

Consumers experience a clear lack of children's preventive footwear of domestic production. Based on the analysis of the design features of preventive footwear, the main design features of footwear are established. To solve the issue of tight fixation of the child's foot and ensure the necessary rigidity of the heel part of the shoe upper, designs have been developed that fix the ankle joint with laces, straps or Velcro. To fix the ankle, a design of the heel part of the shoe is proposed, in which a certain rigidity is created due to technological parameters, namely, an additional unit is used in the heel part, consisting of an outer part, an intermediate part and a lining.

It is shown that anthropometric studies of the feet and the development of scientifically based requirements for the design of footwear for children and adolescents is an urgent problem for the shoe industry. It has been determined that the main factor in the formation of requirements for children's shoes should be the preservation of health, since this age is vulnerable to the action of the external environment. The place of shoes in the complex of health factors is determined. It has been established that footwear has an impact on all categories of health: somatic, personal and social. Thus, the use of orthopedic equipment in standard mass-produced shoes, in the form of insoles and other inserts, can serve as an effective means of improving its preventive properties, including for the flat-valgus foot.

It has been established that anthropometric studies of the feet and the development of scientifically based requirements for the design of shoes for children and adolescents is an urgent problem for the shoe industry. It has been determined that the main factor in the formation of requirements for children's shoes should be the preservation of health, since this age is the most vulnerable. The place of shoes in the complex of health factors is determined. It has been proven that footwear has an impact on all categories of health: somatic, personal and social.

The use of orthopedic equipment in the form of insoles and other inserts in standard mass-produced footwear can serve as an effective means of improving its preventive properties, including preventing flat feet in children. To do this, specialists in the design and manufacture of mass-produced shoes should receive timely current information about new designs of these orthopedic devices, as well as indications for their use.

On the basis of the research conducted to determine consumer preferences, it has been established that currently sold children's shoes with preventive properties have some drawbacks regarding both materials and structural and external features.

Parents of children with pathological abnormalities, including those with flat feet, experience a clear lack of domestically produced children's preventive footwear. Based on the analysis of the features of preventive footwear, its main design features are established. Shoes with preventive properties make up a certain segment of the consumer market for children's and teenage shoes. It is distinguished by the presence of constructive solutions that provide maximum comfort in wearing, the presence of special details (inset anatomical insoles, half-insoles, linings and other corrective details), a rational scientifically based internal shape of the shoe and the use of high-tech materials in the manufacture of shoes, their strict selection according to physical and mechanical and hygienic indicators.

To solve the issue of tight fixation of the child's foot and ensure the necessary rigidity of the heel part of the upper of the shoe, the design of backs is proposed, fixing the ankle joint additionally with the help of laces, straps or Velcro.

To fix the ankle joint, a design of the heel part of the shoe is proposed, in which a certain rigidity is created due to technological parameters, namely, an additional unit is used in the heel part, consisting of an external part, an intermediate part and a lining.

The developed designs of the top of the shoe, together with an anatomical instep support, provide the most effective support for the arch of the foot and correction of the angle of its inclination. Thus, it is important to have a permanent alliance between the podiatrist and the manufacturers of corrective parts in order to guarantee the comfort of the child's foot and high confidence to the parents about the prevention of the development of pathological abnormalities in their child.

Thus, the database combines and structures the information necessary for the fashion designer, reduces the time spent on design and guarantees consumers the manufacture of popular orthopedic shoes, taking into account pathological deviations of children's feet. Based on the conducted research to determine consumer preferences, it has been established that - currently sold children's shoes with preventive properties have some drawbacks regarding both materials and structural and external features;

- to solve the issue of tight fixation of the child's foot and ensure the necessary rigidity of the heel part of the upper of the shoe, the design of the backs is proposed, fixing the ankle joint additionally with the help of laces, straps or Velcro;

– to fix the ankle joint, a design of the heel part of the shoe is proposed, in which a certain rigidity is created due to technological parameters, namely, an additional unit is used in the heel part, consisting of an external part, an intermediate part and a lining;

- the developed design of the upper of the shoe, together with an anatomical instep support, provides the most effective support for the arch of the foot and correction of the angle of its inclination. Thus, it is important to have a permanent alliance between the orthopedist and the manufacturers of corrective parts in order to guarantee the comfort of the child's foot and high confidence to him and his parents about the prevention of the development of pathological abnormalities in their child;

– the concepts of “mass and ultra-customized” shoes are formulated. The definition of “mass-customized orthopedic shoes” means shoes, the design of which is developed on the basis of the average typical features of a group of patients homogeneous by diagnosis. Customization is carried out by adjusting insert corrective elements, design features of models that regulate the volume of the shoe space and frame parts that provide a rehabilitation effect. Ultra-customized shoes are models designed taking into account the individual anatomical features of the foot of a particular patient based on typical designs of mass-customized shoes;

– an analysis of the anthropometric characteristics of the feet of children with cerebral palsy was carried out to clarify the parameters of the lasts of mass-customized shoes. It was revealed that in the regions of the Southern Federal District and the North Caucasus Federal District, shoe lasts for children's orthopedic shoes do not correspond to the average parameters of the feet of children with cerebral palsy. The parameters of lasts for the production of mass-customized shoes for children with cerebral palsy are proposed;

– the degree of consumer satisfaction with the designs of orthopedic shoes made on blocks with corrected parameters was revealed;

– the concept of creating lasts with adjustable volumes for the designs of ultra-customized shoes was proposed;

– an analysis of the assortment of children's orthopedic shoes was carried out, from which 4 basic designs of mass-customized orthopedic shoes with a high rehabilitation effect for patients with cerebral palsy were identified, namely:

boots with adjustable berets;

summer shoes with a high tibia part with an open toe;

summer shoes with a high tibia and a vamp with an elongated tongue;

summer shoes with a high tibia and a closed toe:

- a classification of orthopedic shoes is proposed, based on the rehabilitation effect, which is based on the results of studies on the rigidity of the structure, methods of fixing shoes on the foot, corrective elements of the removable orthopedic insole;

– a method for designing ultra-customized orthopedic shoes using the AutoCAD program was proposed for the following cases:

with different girths of the feet;

with different heights of berets in a pair;

with different track lengths in a pair;

in case of shortening of the lower extremities, a database of designs of mass-customized orthopedic shoes for children with cerebral palsy is proposed, which includes typical designs recommended for this disease in order to make comfortable orthopedic shoes.

The questions considered by the authors are:

the possibility of preventive measures and corrective products to restore impaired functions of children's vital functions;

resuscitation of sharply disturbed functions of the vital activity of the organism of children;

rehabilitation deformity of the feet of children with cerebral palsy;

correction of the deformity of the arch of the foot of children with clubfoot corrective products for restoring impaired functions of the child's body, - practically contain answers to the entire bouquet of questions that parents have, which allows you to make a reasonable choice of corrective products to restore children's impaired vital functions of their body.

Remember that manufacturers use their own sizing charts. Therefore, marking with the same Latin letters does not guarantee that you have two models in front of you that are identical in size. Always carefully read the specifications and see the dimensional grid.

The development of measures was carried out taking into account the strategic goals, legislative acts that determine the policy of the state in the development of light industry in the medium and long term:

Increasing the competitive advantages of the light industry in the production of children's shoes, demand and consumer preferences, technical regulation:

ensuring compliance of Russian products with international standards in terms of quality, environmental safety and design;

increase in production volumes of competitive new generation products with qualitatively new output consumer characteristics, functional properties and with a high share of added value that are in demand by the market;

outpacing growth of the beneficial effect compared to the growth of costs for new and previously mastered types of similar and functionally homogeneous products, efficiency in the execution of orders and consumer requirements.

Technical re-equipment and modernization of the production of children's shoes:

modernization of the bulk of the operating technological equipment, allowing to improve its technical, economic and operational characteristics;

creation of new equipment with a high degree of automation, corresponding to the world competitive level and capable of mastering advanced technologies and ensuring a quick change of assortment, development of technical documentation and requirements for its manufacture;

use of leasing for the purchase of imported equipment or direct purchases of new high-performance imported equipment and spare parts for it that are not produced in our country;

development of VIP-projects (anti-crisis programs) for the financial recovery of the industry, providing for technical re-equipment, modernization, reconstruction and creation of high-tech industries, attraction of foreign capital, investments of Russian business and budgetary funds for their implementation.

Development of innovative activities of the light industry for the production of children's shoes:

implementation of structural and technological restructuring, development of proposals for the preservation and development of the intellectual potential of light industry, the creation of a state scientific innovation center for light industry;

development and development of basic industrial technologies (including nanotechnologies and nanomaterials, systemic information technologies of the intersectoral level), modular and flexible technological systems for the production of competitive world-class science-intensive products used in strategically important areas;

organization of mass production of an innovative product at the enterprises of the industry, including modifications of the product and the technological process, structural changes in the range of manufactured products, training and retraining of personnel for servicing equipment operating on new technologies;

development of international cooperation with foreign countries on the basis of bilateral and multilateral agreements and programs for the development, acquisition and sale of technologies, licenses, holding joint scientific and technical symposiums, conferences, exhibitions.

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