DESIGNING CLOTHES FOR WHEELCHAIR USERS FEATURING ADDITIVE TECHNOLOGIES

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THE ARTICLE CONSIDERS THE PRINCIPLE OF INCLUSIVE PRODUCT DESIGN FOR PEOPLE WITH DISABILITIES AND THE TASKS OF ANTHROPOMETRIC RESEARCH. IT DESCRIBES THE GENERAL REQUIREMENTS FOR CLOTHING FOR THE DISABLED AND CONTEMPORARY METHODS FOR DETERMINING THE DIMENSIONAL FEATURES OF THEIR FIGURES, WHICH DIFFER IN ATYPICAL MORPHOLOGY OF THE STRUCTURE. IT ALSO SHOWS THE PROCESS OF DIGITAL DESIGN OF REHABILITATING FOOT BAGS.

Key Words: rehabilitation products, people with limited mobility, forming frame

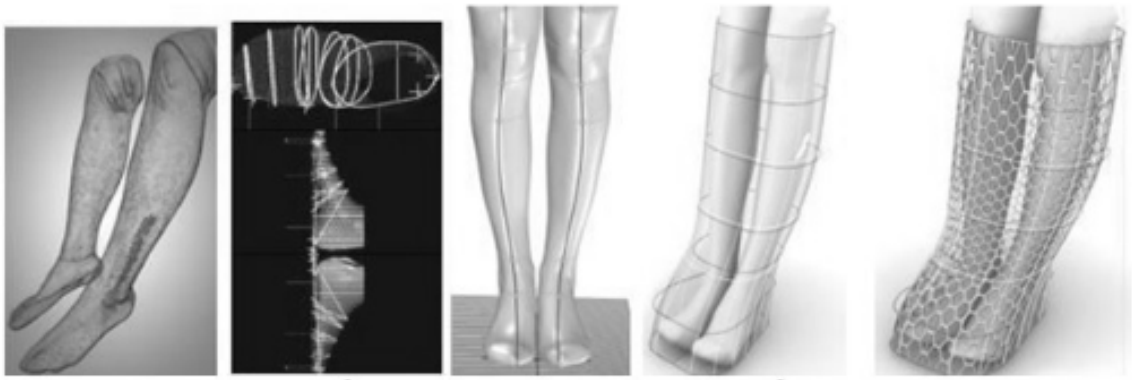
Disability can be accompanied by various limitations on a person's activities and movements [1], distortions and body deformities. To meet the needs of this population group, flexible manufacturing technologies are adapting to the manufacture of personalized products, such as fashionable footwear for diabetic footwear, clothing for wheelchair users and textile compression products [2]. The number of people with disabilities is growing both over time and across the spectrum of disabilities, which makes the search for and purchase of suitable clothing an urgent issue [3]. For people with mobility disabilities, it is important to maintain an ergonomic and psychologically comfortable leg position.

The goal of this research is the development of virtual design technologies for rehabilitation garments with specified properties based on 3D leg scans and the manufacture of form-fitting frames using 3D printing technology.

Preliminary studies were conducted in the form of a survey of potential consumers: wheelchair users with different experience of using a wheelchair and people involved in their care, identified permanent (29%) or periodic (53%) problems with fixing the position of legs on a wheelchair stand. Both women (88 per cent) and men (12 per cent) were respondents, 53 per cent of them aged 16-25, 41 per cent 26-50 and 6 per cent over 50. Consumer preferences in the spatial form, design, design of rehabilitation products have been defined [4]. The majority of respondents prefer a product with a knee and foot cover. Among the factors that determine the choice of rehabilitation bag model for fixing the position of feet in a wheelchair are the comfort of the product and the ease of putting on (45%), the preservation of a given shape (18%), quality (15%), seasonality (9%), ease of care (9%), price (3%), design (2%).

The design of garments for the disabled with atypical morphology of the structure requires additional specific measurements of sufficient accuracy [5, 6]. The most comfortable conditions for anthropometric examinations of people with uncontrolled chaotic movements of limbs and for wheelchair disabled people are provided by contactless methods and scanning tools.

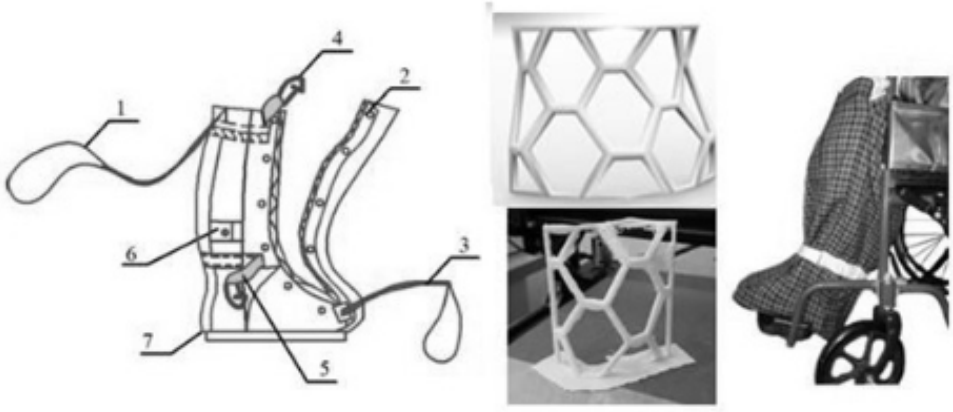
For the experimental anthropometric study of wheelchair disabled people, the method of digital 3D scanning of consumers' legs in the characteristic sitting position was chosen (Fig. 1a). The anthropometric characteristics necessary for the construction of the leg bag have been determined (Fig. 1b, c). On the basis of 3D models of legs, the form-setting skeleton with use of iso-curved lines has been constructed. The program for loading and positioning of the 3D scan, building a system of curves located at a given distance from the object (Fig. 1d) and setting the shape of the projected object at the main horizontal levels, which are then transformed into a surface. The parametric grid of an internal skeleton of a product in which it is possible to change thickness of edges, the form, width, height and quantity of segments (fig. 1d) that allows to supervise degree of conformity of a product on various sites has been created.



a **b** **c** **d** **e**

Figure 1. Stages of the virtual design of a foot bag for rehabilitation:
a - virtual image of the feet; b - 3D anthropometry of the feet; c - 3D anthropometry of the linear dimensions of the feet; d - formation of the 3D shell of the foot bag; e - 3D forming frame

The analysis of 3D digital models of wheelchair disabled people's legs helped to develop design solutions of rehabilitation bags, the spatial configuration of which anatomically corresponded to the leg sketches [7]. The offered rehabilitation products allow to securely fix the positions of both legs [8-10]. Thanks to the small size of the product (Fig. 2 a), the disabled person can put on his or her feet a detachable bag, pulling it up to the level of his or her knees behind the loops (1), fixed in the side seams.



a **b** **c**

Figure 2. Rehabilitation foot bag for wheelchair: a - design solution; b - 3D frame in heel area of the bag; c - product fitting

Similar loops (3) are located in the clasp locks (2) of the bag. The length of the hinges allows the bag to be fastened in the seated position. To adjust the width of the product

along the top edge (4) and at the ankle level (5), tightening clips are provided. To position the feet in a comfortable position, the buckles to the stroller frame (6) and the sole tread (7) are provided for clutching with the footrest. The inner frame defines the shape of the heel and toe zones of the bag. For the production of the inner formative frames of the prototypes (Fig. 2b) the 3D printing technology was used (Fig. 2c).

Experimental study of properties of the developed rehabilitation bags from the point of view of optimization of the shape, quantity, thickness of the product frame ribs and quality assessment is carried out. Testing of the product in operation has shown a high ergonomics of the proposed foot bags due to the conformity of the geometric shape of the product to the anthropometric position of consumers. The comfort of the feet in the wheelchair is ensured by the use of a special bag frame, which makes it possible to give the product an individual spatial shape.

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