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MODERN APPROACHES TO MODELING ORTHOPEDIC FOOTWEAR: EXPERIENCE FROM THE PRAEPARATIO AND GIZ EDUCATIONAL PROGRAMS (GERMANY – UKRAINE)

Purpose. *The main objective of this study is to analyze and summarize the experience gained during the training course on the design and production of orthopedic footwear conducted by German specialists, as well as to identify directions for the further integration of effective European practices into the educational process at the Kyiv National University of Technologies and Design. An important task was to reflect on the differences between the German and Ukrainian systems for training footwear specialists and the production approaches to creating customized footwear.*

Keywords: *Orthopedic footwear, biomechanical diagnostics, foot casting, digital modeling, last, vacuum press, prototype footwear, international cooperation.*

Introduction. Since the beginning of the full-scale war, there has been a sharp increase in the demand for orthopedic care due to the large number of injuries, amputations, and severe traumas sustained by both military personnel and civilians. While limb prosthetics are currently provided at a high level in many centers across Ukraine, the production of orthopedic footwear remains largely overlooked by both specialized state institutions and other competent authorities. Amid the sudden surge in demand for orthopedic products in Ukraine, there are very few enterprises

and specialists capable of producing custom orthopedic footwear. At present, no Ukrainian educational institution trains specialists in the development of complex orthopedic footwear. Recognizing this situation, German specialists from Praeparatio e.V initiated a training program aimed at preparing such specialists.

The purpose of participating in the training program organized by the German partners Praeparatio e.V and GIZ at the Unbroken Prosthetics and Rehabilitation Center in Lviv (September–October 2025) was to enhance the qualifications of Ukrainian specialists in the field of orthopedic footwear production. The program focused on mastering modern German approaches to foot diagnostics, last construction, footwear design modeling, and adapting these methods for the educational and production needs of Ukraine.

Methodology. The training combined theoretical lessons with practical exercises under the guidance of experienced German masters. Participants mastered methods of biomechanical foot diagnostics, studied the casting process using modern materials, learned how to construct an orthopedic last considering the anatomical features of the patient, and explored the specifics of digital footwear modeling.

During the training, participants had the opportunity to independently produce prototype footwear from the film used in Germany to check the conformity of the last shape to the patient's foot before starting full-scale production (Fig. 1). The principles of operation of the AFT vacuum press [1] with a heating mode were also demonstrated, which ensures even material forming and improves the accuracy of fit.



Fig. 1. Prototype footwear made of plastic film

The systematic approach to the development and production of custom orthopedic footwear in Germany, supported by many years of practical experience and continuous improvement of methods, has enabled the creation of a strong industry with high-tech enterprises, professional specialists, and progressive educational programs. These programs provide comprehensive workforce training, integrate traditional craftsmanship with

modern digital technologies, and promote the implementation of innovations in orthopedic footwear production, enhancing its quality, comfort, and functionality for patients.

Trainers Bernd Franke and Franz Fisher emphasized the importance of mastering traditional craftsmanship methods, as well as applying modern technological solutions, reflecting the character of the German school of orthopedic footwear. A well-founded approach to developing the individual shape of orthopedic footwear using traditional methods [2, 3] also formed the basis for more modern techniques implemented with the help of digital technologies.

Research results. The experience gained during the training demonstrated that the German approach to orthopedic footwear production is characterized by more structured processes, standardization, and deep integration of diagnostics at all stages of modeling. The production of prototype footwear is a mandatory step, allowing timely adjustment of the last and verification of its comfort and functionality. Newer materials are used for foot and last casting: polymer casting bandages instead of traditional plaster, and a two-component polyurethane mixture for the last instead of plaster. These materials provide a more accurate reproduction of anatomical shapes and reduce errors in subsequent modeling.

Digital technologies, in particular 3D scanning, are used as an auxiliary tool for creating analytical models of the foot, which facilitates communication between the orthopedic doctor, technician, and shoemaker. 3D printing is actively used in German orthopedic footwear production practice for manufacturing orthoses, shoe lasts, and orthopedic insoles. Although at the Unbroken Center, 3D printers are currently mainly used for producing stump sockets (Fig. 2), mastering the latest digital technologies offers prospects for implementing these advanced methods in the production of orthopedic footwear components. This can serve as an effective aid in establishing the production of custom orthopedic footwear within Ukrainian enterprises using traditional shoemaking technologies.



Fig. 2. Creality FDM printer

During the training, it was also noted that there are certain differences between the German and Italian (which is most used in Ukraine) methodologies for designing orthopedic footwear, particularly in constructing the basic upper structures. For example, a special modeling square by Wilhelm Jordan (Fig. 3) is used for constructing baseline lines and calculations, and on models with stitched uppers, a separate connection point of the components is always marked near the attachment point.

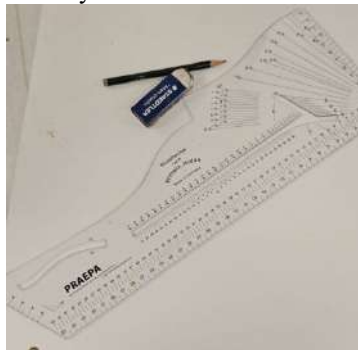


Fig. 3. Modeling square by Wilhelm Jordan

Conclusion. The Praeparatio e.V and GIZ training program confirmed the importance of combining traditional handcrafting methods with digital modeling technologies in the field of orthopedic footwear. This approach allows for increased manufacturing accuracy, product customization, and user comfort. The acquired knowledge should be applied to updating the curricula and practices at KNUTD, contributing to the training of a new generation of highly qualified specialists.

The development of partnership between Ukraine and Germany in the field of orthopedics and rehabilitation is a promising direction, allowing not only the improvement of national technologies but also the integration of Ukrainian specialists into the European system of professional training. International educational programs, such as the one jointly implemented by Praeparatio e.V, GIZ, and Unbroken, demonstrate that the exchange of practical knowledge and experience is the foundation for qualitative changes in the field.

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