


THE PROCESS OF DESIGNING, MANUFACTURING AND ASSEMBLING A COMPUTER MOUSE HOLDER FOR A PERSON WITH HAND DISABILITY

PROCES PROJEKTOWANIA, WYTWARZANIA I MONTAŻU UCHWYTU DO MYSZY KOMPUTEROWEJ DLA OSOBY Z NIEPEŁNOSPRAWNOŚCIĄ DŁONI

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Abstract

The article focuses on the design of a computer mouse holder adapted to the needs of people with hand disabilities, using modern technologies such as CAD design and 3D printing. The goal of the study was to create an ergonomic, functional and easy-to-use solution that would support users' independence in using computer technology. The design process was based on an iterative approach, allowing systematic improvements based on testing and user feedback. The study presents the successive stages of the work - from needs analysis, concept creation, prototyping, to design optimization and final handle design. The use of 3D printing technology made it possible to quickly and cost-effectively produce successive versions of the device and test them under real conditions. The study incorporated the idea of inclusive design, pointing to the potential of modern technologies in creating personalized solutions to support people with mobility barriers in their daily activities.

Keywords: people with disabilities, assistive technologies, inclusive design, prototyping, 3D printing technology

Streszczenie

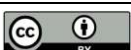
Artykuł koncentruje się na projektowaniu uchwytu do myszy komputerowej, dostosowanego do potrzeb osób z niepełnosprawnością dłoni, z wykorzystaniem nowoczesnych technologii takich jak projektowanie CAD i druk 3D. Celem opracowania było stworzenie ergonomicznego, funkcjonalnego i łatwego w obsłudze rozwiązania, które wspierałoby niezależność użytkowników w korzystaniu z technologii komputerowych. Proces projektowy oparto na podejściu iteracyjnym, umożliwiającym systematyczne wprowadzanie ulepszeń na podstawie testów i opinii użytkowników. Badanie przedstawia kolejne etapy pracy – od analizy potrzeb, przez tworzenie koncepcji, prototypowanie, aż po optymalizację konstrukcji i finalny projekt uchwytu. Zastosowanie technologii druku 3D pozwoliło na szybkie i ekonomiczne wytwarzanie kolejnych wersji urządzeń oraz ich testowanie w warunkach rzeczywistych. W badaniu uwzględniono ideę projektowania inkluzyjnego, wskazując na potencjał nowoczesnych technologii w tworzeniu spersonalizowanych rozwiązań wspierających osoby z ograniczeniami ruchowymi w codziennym funkcjonowaniu.

Słowa kluczowe: osoby z niepełnosprawnością, technologie wspomagające, projektowanie inkluzyjne, prototypowanie, technologia druku 3D

1. Introduction

Motor disability is a condition in which a person's motor abilities are limited as a result of a variety of reasons. It can be a result of both congenital defects and acquired injuries or diseases. Of the most common causes of motor limitations are:

- Congenital absence of limbs or their parts, resulting from abnormal prenatal development.
- Amputations resulting from accidents, medical complications or diseases.
- Nervous system disorders leading to paresis and limited motor control.



- Joint disabilities resulting from both diseases, such as rheumatoid arthritis, and injuries.

People with mobility disabilities are an extremely diverse group in terms of the degree and type of limitations. Some experience only minor difficulties in performing daily activities, while others require specialized assistive equipment to function in society. The difference between lower and upper limb dysfunctions is also an important factor - the former affects mobility, while the latter affects the precision of manual movements (Fundacja Dobro Powraca, 2024).

Mobility disabilities can affect almost anyone at some stage of their life - whether due to illnesses, accidents or the body's natural aging processes. According to the World Health Organization (WHO), there are currently more than a billion people in the world, or about 15% of the global population, who face some form of disability. This number is still growing, mainly due to aging population and an increasing number of chronic diseases (World Bank, 2023).

Mobility disability is not only the physical limitations, surrounding environment and social attitudes play an equally important role in the daily functioning of people with disabilities. There is room for improvement by introducing solutions to facilitate daily functioning of such people. However, in the context of assisting people with mobility disabilities, society focuses on removing architectural barriers, forgetting about other aspects of the functioning of people with disabilities. Equally important, though often overlooked, is the accessibility of technology, which in the modern world plays a key role in everyday life by supporting work, learning and communication.

One of the primary tools used in interacting with computers is the computer mouse, the operation of which can pose a serious challenge for people with hand disabilities, making it difficult to perform basic tasks and affecting their independence in using technology. This applies to people after neurological injuries, with neurodegenerative diseases, after amputations, or with congenital defects that impede grip and motion control. The lack of adapted solutions affects their functioning and limits their professional and social opportunities.

1.1. Inclusive design - the key to accessibility

To effectively eliminate barriers, it is necessary to have inclusive design - an approach that takes into account the diversity of users and their needs. Creating accessible technologies does not have to be complicated or expensive, but a broad view of the needs of people with different limitations is key (Learn Design, 2024) (Barton, 2025).

In the context of computing devices, specialized solutions are already available, but their high price and limited accessibility keep many people from using them. Meanwhile, an inclusive design approach assumes that technologies should be usable by the widest possible audience - not only people with disabilities, but also seniors, traumatized people or those with temporary mobility limitations. Creating solutions tailored to different users needs is not technologically complicated, but it requires a broader view of the diversity of human limitations. Many people face difficulties in their daily functioning that are often overlooked in the standard design process. The right approach and openness to user needs can make technologies more accessible and user-friendly for everyone.

2. Special handle design methodology

The design of a computer mouse handle for people with hand disabilities was carried out based on an iterative approach, which made it possible to systematically improve the prototype at each stage of the design. Thanks to this method, it was possible to adjust the design to the real needs of users on an ongoing basis, which allowed for optimization of the ergonomics, stability and comfort of the device.

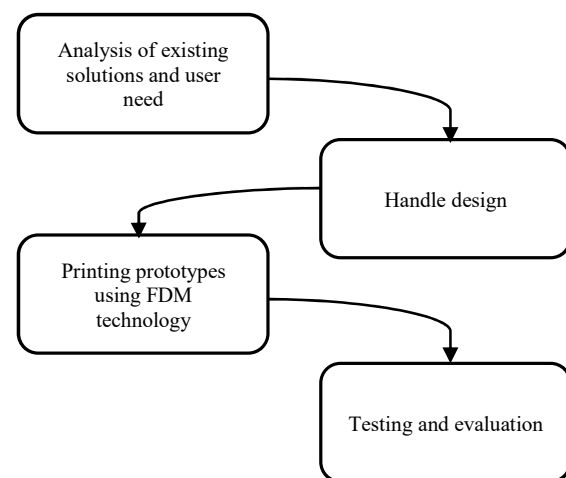


Fig. 1. The process of creating the final product

The first stage of the design was to understand the specific needs of users by analyzing the available solutions and identifying the key requirements for ergonomics, durability and how to mount the handle. Then, based on the collected information, the process of designing the handle began, taking into account the comfort of use and the possibility of integration with different models of computer mice. Once the initial concepts were developed, prototypes were made using 3D FDM printing technology from PLA material, which allowed the design to be quickly tested under

real use conditions. The printed models were subjected to tests, during which users evaluated ergonomics, comfort of use and stability of the grip. Based on the feedback, necessary modifications were introduced to the design, and further tests were carried out, enabling systematic improvement of the design and optimization of the handle for real user needs.

3. FDM printing station

Fused Deposition Modeling (FDM) 3D printing technology was chosen to produce the prototypes, which is a popular and widely available solution for rapid prototyping at relatively low cost. This method allows for instant changes to the design and re-printing of modified versions, which is crucial in an iterative design process. In addition, FDM 3D printing enables the creation of robust and precise models that can be subjected to real-world use testing (3D w praktyce, 2022) (Wang, 2025).



Fig. 2. 3D printing station

PLA (Polylactide) was chosen as the prototyping material, which is a biodegradable material characterized by ease of printing, low shrinkage and good surface quality of prints. PLA has sufficient stiffness, while retaining a certain level of flexibility, making it suitable for testing ergonomic assistive devices (Unionfab, 2024).

In addition, it is one of the cheapest filaments available on the market, which made it possible to reduce the cost of multiple prototyping without sacrificing the precision and functionality of the prints. This made it possible to produce high-quality proto-

types on a minimal budget, significantly improving the iterative process of handle design (Protolabs, 2024).

4. Initial construction assumptions

The first concepts and visualizations were first developed on paper and then transferred to a digital environment using the CAD software SolidWorks. This enabled precise 3D modeling to take into account both the ergonomics and functionality of the device, as well as preliminary structural analysis.

The basis of the design was the development of a stable handle base that was light enough and flat enough to allow easy sliding on the surface of a table or desk. It was also crucial to ensure that the mouse was properly attached. It was decided to use a system of two movable jaws, which were connected by a flexible rubber band to ensure stable retention of the mouse and prevent it from moving from side to side. The mount was to fit both wired and wireless mice, and all the components were connected by screws to allow them to move freely (see Fig. 2). After prolonged analysis, such application did not provide enough stability for the mouse and there would be a risk of the components coming loose during use of the device.

The mechanism of the handle was to be based on a gentle movement of the wrist or light pressure on the appropriate side, allowing activation of the mouse buttons. To achieve this, a movable element mounted on a long screw was designed, which swung from side to side, transferring pressure to arms with ball endings in contact with the mouse buttons. This solution was supposed to enable precise operation while minimizing the risk of accidental button presses. However, it required a high degree of precision in fitting, and differences in the dimensions of commercially available mice limited the functionality of the solution. In terms of user comfort, the first prototype was equipped with a wrist rest and a strap to stabilize the hand on the device.

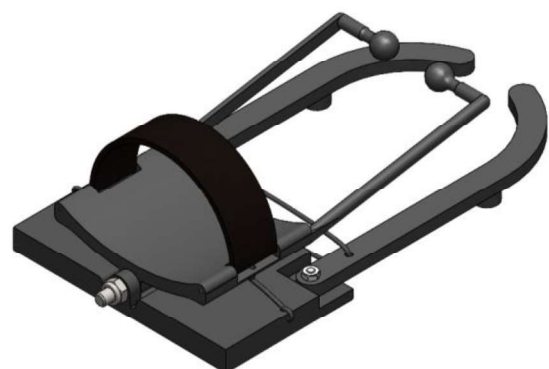


Fig. 3. Visualization of the first concept in Solidworks - isometric view

However, the design of the first prototype revealed several significant problems. The main difficulty was the low functionality of the handle for people with motor limitations. The design contained many small parts (see Fig. 3), such as small screws and fasteners, which could make it difficult for people with limited manual dexterity to use.

Analysis revealed the need for changes. Although the design was originally intended to be universal, it was decided to abandon this feature in favor of adapting the handle to a single standard computer mouse size to improve the functionality and performance of the device.

5. Preliminary design of the product

In the second prototype, a key goal was to minimize the number of components that make up the handle and to simplify its design. In terms of giving up versatility, the devices available on the market were analyzed and the Logitech M185 mouse - a popular, affordable model with a universal design - was chosen. An important aspect was the fact that the device is wireless, which increases the convenience of its use, by not having a tangled cable, and allows greater modifications in the design.

It was decided to design the base of the handle in such a way that it is possible to adapt it to similar mouse sizes, so that it is not just one model. The movable jaws that stabilize the mouse have been removed. Instead, a rigid frame surrounding the device was used, and its immobilization was provided by a clamping screw. In order to simplify the manufacturing process, it was decided to create a hole, a pocket for a nut. This solution allowed easy installation of the screw without the need to inlay an additional threaded element. The changes mainly concerned the design of the handle base (see Fig. 4).

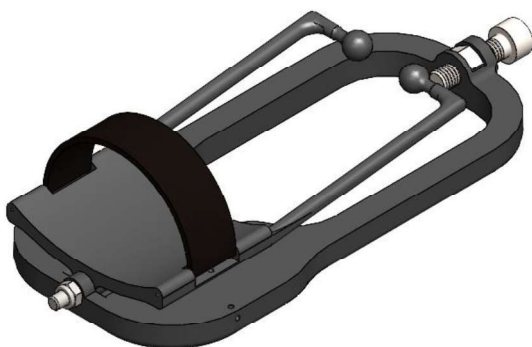


Fig. 4. Visualization of the first prototype - isometric view

After a series of tests in a digital environment, it was decided to make a physical model to verify its performance in practice. The prototype was prepared in BambuStudio software and 3D printed. Testing was

then carried out, the results of which allowed further optimization of the design.

During testing of the prototype, several significant problems related to the geometry and functionality of the handle were identified. One of the main challenges turned out to be the overly complex design of some components, which made it difficult to manufacture them using 3D printing technology. These problems were primarily related to the base of the wrist and the clicking mechanism (see Fig. 5).



Fig. 5. Printing defect of spherical elements

Another important disadvantage was the insufficient rigidity of the components responsible for the click. The design yielded under pressure, which made it difficult and in some cases even impossible for the device to function properly.

Thus, the main problems were in the moving part of the handle, but minor imperfections were also present in the design of the base. The problem turned out to be the mechanism of fixing the mouse with a screw. When it was tightened, the mouse moved upward and fell out of the holder (see Fig. 6).

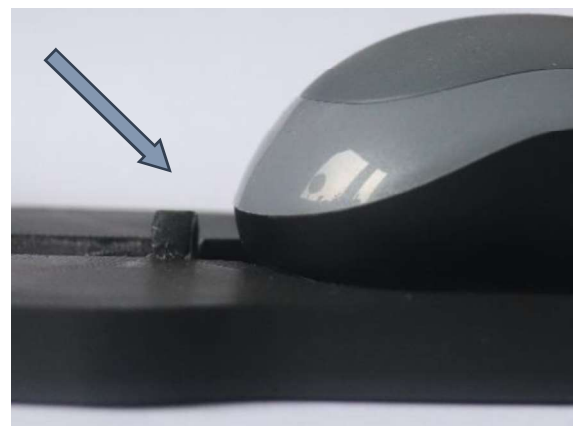


Fig. 6. Zoom in on the base of the handle after tightening the screw

Analysis showed that the problem was due to the insufficient height of the base.

6. Final handle design

In response to the identified problems, a decision was made to modify the design to improve functionality and eliminate process-related defects. As part of the modifications, the walls of the base were raised and elements whose geometry hindered the printing process were changed. In order to increase rigidity, the design of the moving part was completely changed, which not only improved stability, but also affected the ergonomics of the entire handle (see Fig. 7).



Fig. 7. Visualization of the final design - isometric view

During the implementation of the printing process, special attention was paid to the printing parameters, which play a key role for more complex solids. Printing speeds that were too high negatively affected the quality of the prints, causing parts to crack in areas of low material thickness. As a result, the durability of the entire fixture decreased, prompting consideration of further design changes.

Further tests also showed that the new click mechanism did not meet expectations - it exerted too much pressure on the mouse buttons, resulting in the ineffectiveness of the entire handle function (see Fig. 8).



Fig. 8. Close-up of the clicking elements in the second handle prototype

As a result, it became necessary to make further improvements to achieve optimal functionality and product durability.

Due to the lack of access to a person with a real disability, the conditions of use of the mouse holder were simulated by limiting the mobility of the tester's hand — the fingers and hand remained immobile, and all actions were performed only by rotating the wrist or transferring the weight of the wrist to one side of the handle in order to press the button for a longer time without using significant force. Thanks to this approach, it was possible to check whether the handle ensures a stable hand position and whether it allows the intended action to be performed without clenching the hand. Examples of tasks performed with the device included selecting text in a text editor and browsing websites.

7. Summary

The process of designing a computer mouse grip for people with hand disabilities highlighted the importance of an iterative approach in creating ergonomic and functional solutions. Each successive version of the prototype allowed the elimination of previously identified problems and optimization of the design based on actual user needs. Initial assumptions, such as the versatility of the handle, proved difficult to achieve without compromising on stability and user comfort. As a result, it was decided to tailor the design to a specific mouse model, which allowed for better refinement of the design.

Testing of different design variants and analysis of materials and manufacturing technologies enabled gradual refinement of the grip. The geometry and stiffness of the components played a key role, especially in the clicking mechanism, which required modification in subsequent iterations due to difficulties in operation. At the same time, technological aspects such as 3D printing parameters had a significant impact on the final result - improper printing speed or suboptimal component orientation resulted in structural defects and reduced durability of the prints.

In addition to the handle design process, the authors showcased the significance of inclusive design. Adapting technology to meet the needs of people with disabilities doesn't have to be complicated or expensive - the key is to consider diverse users from the concept stage. This approach makes it possible to create more universal and accessible products that realistically improve the comfort and independence of their users.

Conclusions from the work carried out make it clear that designing assistive technologies for people with disabilities requires flexibility and a willingness

to modify initial assumptions. Each element of the design should be thought through in terms of both ergonomics and manufacturing technology. The use of 3D printing made it possible to quickly change the design and test different variants, but at the same time revealed the limitations of this method for more complex mechanisms.

The article is based on an engineering thesis entitled. "Projekt wyrobu ułatwiającego korzystanie z komputera dla osób z niepełnosprawnością dłoni," carried out at Rzeszow University of Technology.

8. Future directions of development

Further development of the project should focus on several key aspects. First, it is necessary to refine the clicking mechanism so that it works smoothly and reliably, minimizing the effort required to operate the mouse buttons. Second, it is worth considering other materials or manufacturing methods that could improve the durability of the grip and enable larger-scale production.

The ultimate goal of the project is to create a product that is not only ergonomic but also functional and available for people with disabilities. Therefore, further work should consider both technological and economic aspects to make the final solution affordable and accessible to a wider range of users.

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