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AGNIESZKA CHUDZIŃSKA
ORCID: 0000-0001-9765-4825
Warsaw University of Technology, Poland

THE BODY CONFRONTING ERROR. ERGONOMICS AS A TOOL FOR DESCRIBING THE ARCHITECTURAL EXPERIENCE

CIAŁO WOBEC BŁĘDU. ERGONOMIA JAKO NARZĘDZIE OPISU DOŚWIADCZENIA ARCHITEKTURY

Abstract

The subject of the article is ergonomic error as a tool for describing the embodied experience of architecture. The aim of the research is to indicate how spatial mismatch reveals the hidden model of the user. The method includes an analysis of student works concerning errors in public, semi-public and private spaces. The result is a typology of four fields of bodily experience: movement, posture, sensory orientation and psychological discomfort.

Keywords: *architectural experience, body, ergonomic error, ergonomics, neuroarchitecture*

Streszczenie

Tematem artykułu jest błąd ergonomiczny jako narzędzie opisu cielesnego doświadczenia architektury. Celem badań jest wskazanie, jak niedopasowanie przestrzeni ujawnia ukryty model użytkownika. Metoda obejmuje analizę prac studenckich dotyczących błędów w przestrzeniach publicznych, półpublicznych i prywatnych. Wynikiem jest typologia czterech pól doświadczenia ciała: ruchu, postawy, orientacji zmysłowej i dyskomfortu psychicznego.

Słowa kluczowe: *architektura, błąd ergonomiczny, ciało, doświadczenie, ergonomia*

1. INTRODUCTION. ARCHITECTURE AS A BODILY EXPERIENCE

Architecture is experienced through the body: through movement, touch, sight, hearing, balance, temperature, weight, fatigue, and the memory of previous encounters with space. The user does not merely look at a building but moves through it, touches its elements, navigates around obstacles, seeks support, and reacts to light, texture, reverberation, scale, and the resistance of materials. Architecture thus reveals itself not in a single moment but sequentially – over time, in motion, in accordance with the sequence of events.

Everybody experiences space differently. Height, age, physical ability, walking pace, vision, sensitivity to sound, light, and temperature, as well as a sense of safety, all influence

whether a given space is perceived as comfortable. What may be a neutral element of the environment for one person can become a barrier, a source of tension, or a threat for another. Therefore, architecture is not a universal experience, but always occurs in the relationship between a specific space and a specific body. In this context, an ergonomic error has particular cognitive significance. It reveals the moment when architecture ceases to function in accordance with the user's needs. The body is the first to recognize this mismatch through pain, discomfort, unsteady gait, forced posture, disorientation, eye strain, or a sense of danger. An ergonomic error thus demonstrates that architecture is not merely viewed, but above all experienced and tested in use.

2. ERROR AS A COGNITIVE TOOL

An error is commonly understood as a deviation from an established rule, expected result, or correct measurement. In scientific reflection, however, it may be treated not only as a shortcoming requiring correction, but also as evidence that the adopted description of reality is insufficient.

This broader understanding of error is present in Thomas Kuhn's concept of scientific development[1]. Science operates within paradigms that define accepted concepts, methods, and ways of interpreting facts. Most discrepancies can be explained without challenging the prevailing framework. An anomaly that affects its fundamental assumptions may, however, reveal the limitations of the existing model and initiate a change in the way a problem is understood.

This mechanism can be applied to architecture and ergonomics. An ergonomic error may be more than a dimensional, technical, or construction flaw: it can reveal the limitations of the adopted user model. A design may meet formal requirements and remain spatially coherent, yet cause discomfort, disorientation, physical tension, or a sense of danger. The body then becomes a diagnostic tool, signaling that the space does not function as intended.

A significant paradigm shift in ergonomics occurred when design began to move away from the "average" user model and increasingly took into account the needs of people with disabilities, older adults, and users with limited mobility, perception, or strength. From this perspective, ergonomics is no longer solely about adapting spaces to an average body type, but about recognizing the diverse ways in which architecture is used. Contemporary accessibility audits, universal design, and tools such as the Inclusive Design Toolkit shift the focus from whether a space meets basic dimensions to who can use it independently, safely, and without feeling excluded. Including people with disabilities in everyday design thus reveals the limitations of the previous paradigm and shows that ergonomics must account not for a single body, but for many different bodies, abilities, and ways of experiencing space.

3. FROM IMAGE TO USE

Architecture is often described as a visual composition, yet it is encountered through movement, touch, effort, sound, temperature, and material resistance. The user is therefore

[1] T.S. Kuhn, *Struktura rewolucji naukowych*, Wydawnictwo Aletheia, Warszawa 2020, pp. 145–165.

not a detached observer but an embodied participant whose experience unfolds over time. This perspective corresponds to the phenomenological understanding of perception[2]. Maurice Merleau-Ponty placed the body at the center of the experience of the world. A person does not perceive reality as a detached mind looking at an external image, but as a body immersed in the world and constantly connected to it. The body is not merely a tool for movement or a biological vehicle for the senses, but a fundamental condition for perception, action, and orientation. In this sense, architecture does not exist for the user as an abstract form, but as a set of bodily situations: passages, pauses, turns, tensions, touches, distances, and resistances.[3]

Juhani Pallasmaa develops a similar line of thought, criticizing the dominance of sight in architectural culture. In his view, the experience of architecture is multisensory and haptic.[4] Sight is not an isolated sense but operates in conjunction with touch, bodily memory, movement, and awareness of scale. Architecture is therefore perceived in relation to the body: the city through stride, doors through resistance, and interiors through temperature, sound, scent, and texture. A building can invite or repel, guide or disorient, calm or unsettle its user. Pallasmaa's description of the doorknob as the building's "handshake" captures this direct bodily encounter with architecture.

Experience therefore shifts architectural analysis from appearance to use. A space may be visually coherent yet tiring, disorienting, or exclusionary. Ergonomic error makes this mismatch visible when the user slows down, changes posture or route, seeks support, or withdraws. Such bodily reactions can be treated as design data and used in the critical analysis of architecture.

4. TYPOLOGY OF ERROR: FOUR FIELDS OF BODILY EXPERIENCE

Using the analytical material collected during the Ergonomics course taught as part of the *Architecture of Society of Knowledge* program at the Faculty of Architecture, Warsaw University of Technology, four fields of bodily experience were identified as a starting point for a broader interpretation of the relationship between the body and architecture. The study involved 17 students, each of whom analyzed one case in each of 16 functional and spatial categories, producing a total of 272 analytical sheets. The task consisted of identifying and documenting through photographs ergonomic errors occurring in public, semi-public and private spaces. The students analyzed specific situations, indicating the error category, user group, nature of the problem, its consequences and a possible direction for design correction. Each analysis followed a consistent structure comprising metadata, error classification, user identification, analytical description, consequences, ergonomic relationship and a proposed solution. Based on recurring patterns, four fields of bodily experience in architecture were distinguished: the body as a measure, the body in motion, the sensory body, and the body in functional and social relationships.

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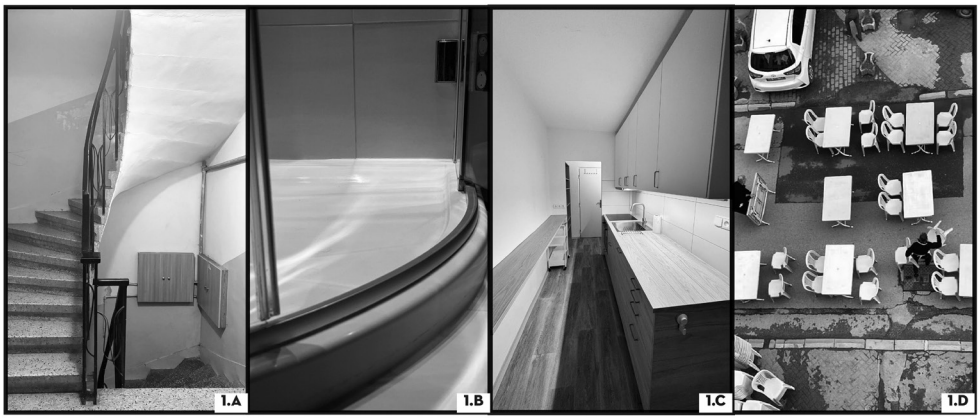
[2] M. Merleau-Ponty, *Fenomenologia percepcji*, Wydawnictwo Aletheia, Warszawa, 2001, pp. 100, 160, 169.

[3] *Ibidem*.

[4] J. Pallasmaa, *Oczy skóry. Architektura i zmysły*, Instytut Architektury, Kraków 2012, pp. 26–29, 78.

4.1. MOTION, BALANCE, AND FALL RISK

The first area of bodily experience concerns movement, balance, and the risk of falling. This group includes errors that are not always associated with a single incorrect dimension, but rather with a disruption in the continuity of movement. The user's body does not move through space in an abstract manner. Every step requires assessing the ground, perceiving edges, sensing slopes, grasping a handrail, determining the distance to an obstacle, and anticipating the movements of others. An ergonomic error occurs when the space ceases to support these actions and instead requires increased caution, compensation, or withdrawal. In the analyzed examples, this type of error occurs, among other places, on stairs with improper proportions (Ill. 1A), at shower thresholds (Ill. 1B), in kitchen passageways that are too narrow (Ill. 1C), and in temporary food service layouts with unclear circulation layout (Ill. 1D). In each case, the problem is not merely a single dimension, but a disruption of the natural sequence of movement. The space begins to require the body to compensate, and for children, the elderly, people with limited mobility, or fatigued users, this can pose a real risk of tripping, falling, or colliding.

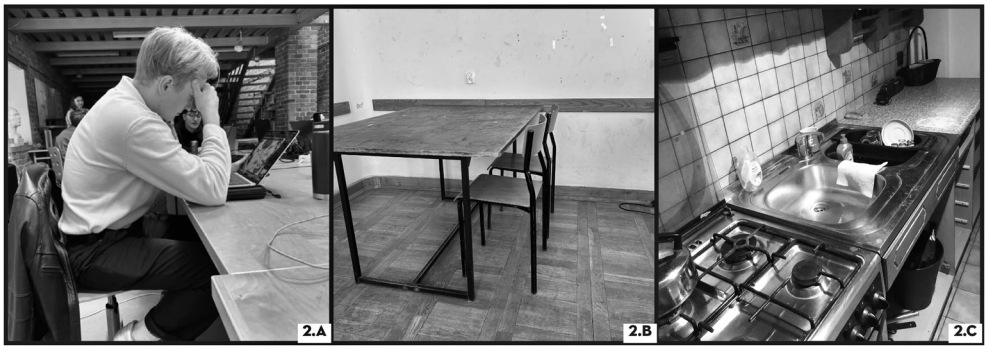


Ill. 1. A – Stairs in Istanbul: incorrect step proportions and restricted movement, photo: Sadik Yusuf Ceylan; B – raised shower threshold disrupting movement continuity, photo: Julian Gajdos; C – kitchen passage approximately 70 cm wide, photo: Saša Šimečková; D – dining layout with narrow and unclear circulation routes, photo: Sadik Yusuf Ceylan

4.2. POSTURE, REACH, AND FORCED EFFORT

The second aspect of the bodily experience encompasses posture, reach, and forced effort. This is the most classic area of ergonomics, but in the context of this analysis, it is not solely about compliance with anthropometric standards. What is more important is recognizing situations in which the design forces the body into a specific, unnatural position. The body must then compensate for the mismatch within the workspace: it bends, twists, reaches out, tenses the shoulders, strains the spine, raises the arms, or maintains a static position without the possibility of rest. The analyzed examples include, among others, laptop screens positioned too low (Ill. 2A), seats without adjustment or lumbar support (Ill. 2B), as well as kitchens and bathrooms that force users to work within a restricted range of motion (Ill. 2C). In such

situations, the user tilts their head, tenses their back, twists their body, leans on something, moves furniture, or changes the way they perform tasks. The problem is thus experienced as fatigue, pain, stiffness, and the need for constant postural correction.



Ill. 2. A – laptop screen positioned below eye level, forcing cervical flexion, photo: Bartłomiej Warmiak; B – classroom chairs without adjustment or lumbar support, photo: Maria Makarczyk; C – sink placed directly beside a gas stove, without a work-surface buffer, photo: Jacek Kostrzewa

4.3. VISION, ORIENTATION, AND SENSORY OVERLOAD

The third area of bodily experience concerns vision, orientation, and sensory overload. In this group of errors, the architecture does not so much hinder movement through a physical obstacle as it disrupts the recognition of the situation. The user cannot see edges, direction, the work object, obstacles, or the relationships between elements of the space clearly enough. An ergonomic error arises at the intersection of vision, light, contrast, texture, and orientation. The analyzed examples include, among others, workstations positioned so that light reflects off the screen (Ill. 3A), intense monochromatic lighting that makes it difficult to distinguish colors and spatial boundaries (Ill. 3B), and cold, high-contrast lighting in recreational areas (Ill. 3C). In each case, the problem is not merely the amount of light, but its relationship to function, the body, and the way the space is used. Poor lighting forces the user to squint, change position, slow down movement, seek contrast, or constantly adjust their vision. Ergonomics thus allows us to describe vision not as passive looking, but as an activity related to orientation, safety, body tension, and the ability to act.



Ill. 3. A – workstation affected by screen glare, photo: Tomáš Vojtíšek; B – monochromatic red lighting reducing contrast and color recognition, photo: Bartłomiej Warmiak; C – recreational path illuminated by cold, intense light, photo: Beata Pająk

4.4. PSYCHOLOGICAL DISCOMFORT, EXPOSURE, AND A SENSE OF THREAT

The fourth realm of bodily experience encompasses psychological discomfort, exposure, and a sense of threat. This realm is particularly significant because it demonstrates that ergonomics extends beyond biomechanics. An ergonomic flaw can be experienced not only as back pain, eye strain, or restricted movement, but also as tension, embarrassment, uncertainty, a lack of control, a sense of being on display, or a fear of losing stability. The analyzed examples include, among others, a transparent floor in a dining area (Ill. 4A), intense or cold lighting that alters the atmosphere of the space (Ill. 4B and 4C), and a restroom for people with disabilities with a grab bar on the wrong side (Ill. 4D). These elements may be technically sound or visually appealing, but in use they evoke uncertainty, tension, a sense of exposure, or dependence on others. In this context, the difference between architecture as it is viewed and architecture as it is experienced is particularly evident: the problem is not merely the risk of injury, but the inadequacy of the space for diverse users. A place that induces tension, dependence on others' assistance, or a sense of exposure ceases to be fully accessible and begins to function in an exclusionary manner.



Ill. 4. A – transparent floor causing a sense of exposure, photo: Sadik Yusuf Ceylan; B – red club lighting increasing tension, photo: Bartłomiej Warmiak; C – cold lighting conflicting with the recreational character of a path, photo: Beata Pająk; D – grab bar installed on the wrong side of an accessible restroom, photo: Maria Makarczyk

5. ERGONOMIC ERROR AS A TRACE OF THE HIDDEN USER

An ergonomic error also reveals the user model embedded in a design. Every space assumes a body with particular dimensions, abilities, sensory capacities, and a sense of safety. Problems arise when this model is too narrow to encompass the actual diversity of users. Historical anthropometric models were long based on an average or idealized user. Later resources – including Henry Dreyfuss's *Joe and Josephine*[5], NASA[6], the DINED

[5] A.R. Tilley, Henry Dreyfuss Associates, *The Measure of Man and Woman: Human Factors in Design*, John Wiley & Sons, New York 2002, pp. 22–25.

[6] National Aeronautics and Space Administration, *Man-Systems Integration Standards*, vol. 1, NASA-STD-3000, Revision B, Lyndon B. Johnson Space Center, Houston 1995, https://www.abbottaerospace.com/downloads/nasa-std-3000-vol-i-2-man-systems-integration-standards-vol-i/ (access: 27.08.2026).

database[7], and the CAESAR project[8]– more clearly recognized differences in age, gender, height, physical ability, population background, and conditions of use. When the adopted model is too narrow, error becomes a concrete bodily experience: fatigue, pain, restricted movement, sensory overload, or the need for compensation. Bernardino Ramazzini had already demonstrated this principle in 1700 by linking prolonged sitting, repetitive postures, noise, bent working positions, and muscular strain to specific health consequences[9]. Although his observations preceded modern ergonomics, they show how the body reveals environmental flaws through accumulated stress.

The student examples frequently reveal spaces designed for an able-bodied, sighted adult of average height and without mobility limitations. An ergonomic error therefore indicates not only what is wrong, but also who has been excluded from the assumed user model. It exposes the designer's unstated assumptions and shows who can use a space comfortably and who must compensate for its limitations. Ergonomics can thus support critical reflection on architecture as an environment that either supports the body or forces it to adapt.

6. SUMMARY

The analysis conducted shows that an ergonomic error is not merely a technical, dimensional, or functional shortcoming, but rather the moment in which architecture reveals itself as a bodily experience. It is the body that first recognizes the mismatch of the space: through tension, pain, loss of balance, disorientation, fatigue, uncertainty of movement, or a sense of danger. Architecture is thus experienced multisensorily and sequentially. An ergonomic error reveals hidden design assumptions about the user. It shows whether a space was conceived for an able-bodied, adult, sighted, tall, short, strong, and confident person – or whether it takes into account the actual diversity of bodies and ways of using the space. Analyzing these errors can serve as a tool for critical reflection on architecture.

Currently, neuroarchitecture is bringing about a paradigm shift in ergonomics, by shifting the focus from the mere functionality of a space to its measurable impact on the user's body, brain, and behavior. Design is no longer concerned solely with dimensions, accessibility, and comfort, but also with biological processes: sleep, recovery, concentration, appetite, a sense of security, and social relationships. The examples are very specific: the orientation of a bed relative to the cardinal directions can affect sleep quality[10]; the light from a television and the blue spectrum of LEDs delay melatonin secretion and disrupt the ability to fall asleep[11]; the

[7] Delft University of Technology, *DINED Anthropometric Database*, https://dined.nl/en/database/introduction (access: 13.07.2026).

[8] SAE International, *Civilian American and European Surface Anthropometry Resource – CAESAR: Final Report*, vol. 1, *Summary*, 2002.

[9] B. Ramazzini, *De morbis artificum diatriba*, Typis Antonii Capponi, Mutinae 1700, cap. XXII, XXXII–XXXIII, XXXVII, pp. 183–192, 231–240, 259–265.

[10] A. Hekmatmanesh et al., *Bedroom design orientation and sleep electroencephalography signals*, "Acta Medica International" 2019, no. 6(1), pp. 33–37, https://doi.org/10.4103/AMI.AMI_60_18 (access: 28.08.2026).

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color temperature of light alters the perception of food's taste[12]; the scent of wood and natural materials enhance the sense of home[13]; the acoustics of the dining room affect the comfort of conversation and mealtime[14]. Similarly, the kitchen can no longer be evaluated solely by the classic work triangle, as food safety studies highlight the importance of micro-distances between the sink and the countertop and users' actual habits[15]. The mechanical properties and texture of flooring materials' surfaces affect the perception of somatosensory stimuli and gait dynamics. Comparative studies of walking surfaces have shown that wood, due to its greater elasticity and capacity to absorb impact loads, may promote a more stable gait pattern than concrete or cement-based surfaces.[16] In this sense, neuroarchitecture expands the scope of ergonomics: a design flaw may stem not only from incorrect dimensions but also from a failure to account for the nervous system's responses, biological rhythms, sensory perception, and the physiology of everyday use of space. From this perspective, ergonomics ceases to be merely a set of standards and dimensions but becomes a tool for determining whether architecture truly supports the user's body or forces it into constant compensation, caution, and adaptation.

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Author's Note

Agnieszka Chudzińska, PhD, Architect

Assistant Professor at the Faculty of Architecture, Warsaw University of Technology. Her research focuses primarily on brine graduation towers, their construction, maintenance, and operation within spa environments. Her second area of interest concerns isolation spaces, protective structures, and shelters in the context of contemporary security needs and dual-use design. She also addresses issues related to interior design, spatial experience, and ergonomics. She is a member of the Mazovian Regional Chamber of Architects of the Republic of Poland.

agnieszka.chudzinska@pw.edu.pl