

ERGONOMICS IN INDUSTRIAL DESIGN

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Abstract. *This article analyzes the aspect of design which prioritizes comfort, safety and efficiency in order to enhance people's productivity. Ergonomic design not only boosts productivity but also fosters a positive work. It encompasses the study of how humans interact with products, environments, and systems to optimize safety, efficiency, and user satisfaction. By understanding the human need, designers can create products that enhance user experience and reduce the risk of injury, ultimately fostering a harmonious relationship between people and the products they interact with. The author explains the stage for exploring the significance of ergonomics in industrial design and its impact on shaping modern-day products and environments.*

Keywords: *design, ergonomics, efficiency, functionality, shaping, safety, modern-day products.*

Introduction

“Ergonomics is the silent force behind workplace satisfaction.” Ergonomics, also referred to as human factors or human factors engineering (HFE), applies the psychological and physiological principles to the design and engineering of products, processes, and systems [1].

The primary objectives of human factors engineering include reducing human error, enhancing productivity and system availability, and improving safety, health, and comfort. It specifically emphasizes optimizing the interaction between humans and equipment. Industrial designers perform a crucial role in shaping the functionality and efficiency of different projects. Not long ago, designers were known as eclectic generalists who sought to understand the basic knowledge of the world through various subjects such as art, science, and physics. By adopting a human-centered approach, designers focus on understanding user needs, leading to the development of tools that reduce different problems. Through that knowledge was created a pivotal aspect of industrial design philosophy named ergonomics, the science of creating products and workplaces that harmonize with the human body.

What is Ergonomics?

The word “ergonomics” aims to design appearance, technical systems and theory that eventually will optimize the human health, comfort and safety. Ergonomic design aims to reduce the risk of musculoskeletal disorders, enhance performance and create a conducive work environment. The formal definition of ergonomics, approved by the IEA, reads as follows [2]:

“Ergonomics (or human factors) is the scientific discipline concerned with an understanding of the interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design, in order to optimize human well-being and overall system performance” [2].

Ergonomic design not only boosts productivity but also fosters a positive work environment, ultimately shaping our future where technology integrates seamlessly to optimize the human experience in industrial settings.

What are the most important principles used in ergonomic design?

Accessibility. The principle of accessibility asserts that designs should be usable by people of diverse abilities, without special adaptation or modification. In order to create a good . There are four characteristics of accessible designs: perceptibility, operability, simplicity, and

forgiveness. Perceptibility is achieved by consumers when the design can be perceived and when the design information provides compatibility with assistive sensory technologies [2]. Operability is ensured when people of all physical abilities can effectively use the design. Fundamental strategies for improving operability include: reducing repetitive tasks and physical effort requirements, implementing easy-to-use controls with clear capabilities and limitations, and positioning information in a way that is accessible to both seated and standing users [3]. Simplicity is achieved when the design is easy for individuals to understand and navigate, regardless of their level of experience, literacy, or focus. Key techniques for improving simplicity include: removing unnecessary complexities, consistently labeling controls and modes of operation, using progressive disclosure to present pertinent information and controls, providing clear guidance and feedback for all actions [3]. Forgiveness is achieved when designs mitigate the occurrence of errors. Basic strategies for improving forgiveness include: incorporating effective capabilities to prevent errors, using confirmations and warnings to reduce error rates, and integrating reversible actions and safeguards to mitigate the impact of errors [3].

Affordance. Objects and environments are better suited for certain functions. For instance, round wheels are more conducive to rolling than square wheels, and stairs are more suitable for climbing than fences. This alignment between the characteristics of an object or environment and its intended function is known as affordance. When affordances match intended functions, designs perform more efficiently and are easier to use. Conversely, when affordances conflict with intended functions, designs perform less effectively and become more challenging to use. For example, a door with a handle suggests pulling, but if it's meant to be pushed, this creates a conflict. By replacing the handle with a flat plate, the door now suggests pushing, aligning with its intended function and improving usability. Ultimately, when affordances are effectively utilized, it becomes difficult to imagine the design functioning or being used differently.

Environmental factors

Noise. Exposure to high levels of noise during tasks can lead to annoyance and, over time, cause hearing impairment. An initial sign of hearing loss is struggling to understand speech in noisy settings like parties or pubs. In such situations, hearing aids prove ineffective as they amplify background noises alongside speech. Even at moderate noise levels, annoyance can arise, disrupting communication and reducing the concentration. To prevent annoyance and hearing impairment, it is crucial to establish upper limits for noise levels, typically measured in decibels (dB(A)). There are many possibilities for achieving a noise reduction as selecting a quiet working method or to use quiet machines.

Vibration. When discussing vibration, it's important to distinguish between whole-body and hand-arm vibration. Whole-body vibration involves the entire body experiencing vibrations, typically through the feet or seat, as in standing or seated work, respectively. This type of vibration is usually vertical, common in vehicles. Hand-arm vibration, on the other hand, affects only the hands and arms, often occurring when using motorized handheld tools.

“Three variables are important in assessing vibrations: their level (expressed in), their frequency (expressed in Hz) and the exposure duration. Low-frequency body vibrations (<1Hz), can produce a feeling of seasickness. Body vibrations between 1 and 100Hz, especially between 4 and 8Hz, can lead to chest pains, difficulties in breathing, back pain and impaired vision. The possible consequences of hand-arm vibration frequencies between 8 and 1000Hz are reduced sensitivity and dexterity of the fingers. The most common frequency range for handheld motorized tools is between 25 and 150Hz” [1].

When direct measures to mitigate vibration at the source are insufficient, the focus shifts to reducing its transmission. This is achieved by damping the vibration where it enters the body, such as by incorporating damping materials into floors, seats, and hand grips. For instance, a well-damped seat in a bus minimizes vibrations from reaching the body by fitting the seating surface

with damping materials and incorporating pneumatic springs between the seat and floor for additional damping.

Illumination. Sufficient light intensity is essential for rapid, precise, and comfortable performance of visual tasks. Additionally, differences in luminance (contrast) in the visual field are crucial. Light intensity is measured in lux, while luminance (brightness) is measured in candela per square meter (cd/m^2).

In non-critical areas like public corridors or storage rooms, a light intensity of 10-200 lux is sufficient, as long as reading is not necessary. For detecting obstacles, a minimum intensity of 10 lux is needed.

For typical visual tasks like reading or operating machines, consider the following guidelines:

- A light intensity of 200 lux suffices if the information is large and contrasts well with the background.
- Higher light intensities are needed for smaller details or poor contrast.
- Individuals with limited vision or older adults may require even more light.

To maintain visual comfort, it's important to minimize excessive differences in brightness across the visual field. These differences can arise from reflections, glaring lights, or shadows, leading to discomfort and reduced visibility.

Utilizing daylight for ambient lighting is a beneficial practice in design. Incorporating available daylight into general lighting schemes not only enhances illumination but also provides occupants with views to the outside, which is generally preferred. However, it's important to mitigate large variations in daylight intensity, especially near windows, to prevent discomfort or glare. Blinds can help control direct sunlight, but may lead to uneven brightness in the visual field. To avoid the blinding effects from direct light, screening-off sideways radiation is recommended, although this may result in less illumination on vertical surfaces. This can be counteracted by choosing a lighter interior color scheme, thereby optimizing both visual comfort and efficiency in the workspace.

Conclusion

Integrating ergonomic principles into industrial design is paramount for creating products and environments that prioritize accessibility, usability, and user's well-being. By considering factors such as accessibility for diverse user needs, affordance to ensure intuitive interaction, minimizing vibration and noise to enhance comfort and safety, and optimizing the illumination for visual clarity and comfort, designers can craft solutions that cater to the diverse needs and preferences of users. As technology evolves and design trends shift, maintaining a steadfast commitment to ergonomics remains essential for fostering inclusive, user-centered design practices that ultimately enhance usability, efficiency, and satisfaction across various industrial contexts. By prioritizing ergonomic considerations, designers can unlock the full potential of their creations, fostering environments that promote productivity, comfort, and overall quality of life for users.

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