



## Historical Evolution of Industrial Design Terminology: Examples of Terms Formation

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### Abstract

Industrial design discourses are predominantly constructed upon systems of thought appropriated from various disciplines, including economics, philosophy, and sociology. In a historical context, it becomes evident that the terminology associated with industrial design has primarily been established through the adoption and contextualization of concepts from more advanced fields of study. The evolution of industrial design terminology mirrors the socio-cultural understanding of the era in which the practice occurs. Despite the historical influence of diverse disciplines, industrial design has cultivated its distinctive narrative by reinterpreting the concepts sourced from these areas. This study, arranged in chronological order, examines how industrial design discourse has progressed through different historical periods, elucidating the transformations and alterations of fundamental concepts derived from various academic fields along the design continuum, as well as the role of interdisciplinary interactions in shaping design terminology, illustrated through sample concept products. In the study, a hybrid approach that integrates narrative review with historical-conceptual analysis is adopted. The research is grounded in the literature on design theory and history, professional association reports seminal statements by influential designers, and critical examinations of iconic design objects.

## 1. INTRODUCTION

The term “term” is defined by the Turkish Language Association as “a word that corresponds to a special and specific concept related to a field of science, art, profession, or subject,” while “terminology” is defined as “the science of terms.” Terminology represents a discipline that scrutinizes the naming, definition, and systematization of concepts specific to distinct fields of expertise [1].

In the 18th century, terminology, emerges as a necessary tool alongside the expansion of technology, communication, and the simultaneous accumulation of knowledge to address the challenges associated with these advancements. It acquires a scientific orientation only in the 20th century [2]. In the 19th century, the necessity for scientists to establish guidelines for the formulation of terms within their respective disciplines became apparent due to the escalating internationalization of science. Botanists (in 1867), zoologists (in 1889), and chemists (in 1892) articulated this necessity at their corresponding international meetings [2]. While scientists pioneered the development of terminology during the 18th and 19th centuries, engineers and technicians contributed to these efforts in the 20th century [2]. The accelerated pace of technological advancement generates a demand for the designation of new concepts and a requirement for consensus regarding the terminology employed. During the industrial era, the proliferation of education and the growing importance of written communication necessitated the codification of languages and the establishment of standardized writing systems. Consequently, in conjunction with natural language, the notion referred to as “standard language” emerged [2].

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The process of generating terminology within any particular domain—specifically, the emergence and systematization of novel terms—can be elucidated through both linguistic and epistemological frameworks. For instance, the introduction of a scientific discovery, a technological innovation, or a pioneering idea engenders the necessity for a new concept to be designated [3]. A completely original word may be formulated for the specified concept; alternatively, a new term may be derived from an existing lexeme; or an established word may acquire new, specialized meanings specific to the domain [2].

Industrial design terminology falls within this third category in the given context. The evolution of terminology in industrial design, an emerging field, was notably advanced by the scientific, cultural, and technological progress of the 20th century. Consequently, it can be asserted that the terminology of this field primarily comprises established terms from other disciplines. Through analogy, terms borrowed from diverse fields are assimilated with new, domain-specific meanings. In the literature, studies on industrial design terminology are typically limited to specific concepts or confined to particular historical periods. While such works contribute valuable insights into the development of certain terms or phrases, there appears to be a lack of comprehensive research that examines how design terminology has been shaped through interdisciplinary influences over time, and how these conceptual shifts are situated within the broader discourse of design.

This study examines the evolution of industrial design terminology through the lens of cross-disciplinary conceptual appropriation and recontextualization. Specifically, it elucidates how core concepts from various academic disciplines, such as engineering, architecture, psychology, and sociology, are transformed and internalized in the process of shaping the distinctive discourse and identity of the industrial design discipline. To achieve this, the study employs a narrative review methodology, supplemented by historical-conceptual analysis, to offer a contextual synthesis of key concepts and their transformations across different historical periods. Given the interdisciplinary and historically embedded nature of industrial design, this approach is well-suited to mapping the evolution of terminology by integrating diverse strands of literature. The study draws on a variety of data sources, including literature on design theory and history, seminal statements by influential designers, reports from professional associations, and interpretive readings of significant design artifacts from various periods. This framework underscores that terminology is not merely a linguistic phenomenon, but also a marker of the permeability of disciplinary boundaries and the circulation of knowledge across fields.

The selection of key concepts in this study is grounded in their representational value for critical historical junctures and epistemological shifts in the evolution of industrial design discourse. Functionality and standardization epitomize the modernist pursuit of efficiency and order in the early 20th century. Ergonomics and usability reflect the post-war focus on optimizing human-machine interfaces within increasingly complex systems. The emergence of user experience and emotional aesthetics during the 1980s coincides with the proliferation of digital media and the rise of experience-oriented, human-centered design approaches. Finally, sustainability and participatory design, gaining prominence from the 1990s onward, are indicative of a shift toward systemic thinking, where ethical, environmental, and sociopolitical considerations become integral to design practice and terminology. To underscore the significance of this study for industrial design, the subsequent section examines the importance of the concepts of terms and terminology within the field.

## **2. TERMS AND TERMINOLOGY**

Modern terminology began to take shape in the 1930s, primarily through the contributions of E. Wüster. In his doctoral dissertation, Wüster advocated for more systematic approaches to terminology work, proposed foundational principles for managing terms, and outlined a methodology for organizing terminological data. The initial phase of terminology studies (1930–1960) concentrated on establishing structured methods for the formation of terms [2]. In the subsequent stage of development (1960–1975), the most significant innovations in terminology emerged from advancements in mainframe computing and documentation techniques. During this period, the first databanks were established, and the international coordination of principles about terminology processing was initiated. Notably, this stage

marked the earliest efforts to standardize terminology within specific linguistic communities, reflecting a burgeoning interest in unifying concepts and terms across various disciplines and within distinct linguistic contexts. The third phase, commonly referred to as the "terminology boom" (1975–1985), was distinguished by a proliferation of language planning and terminology initiatives [2]. The widespread adoption of personal computers during this era significantly enhanced the potential for processing and organizing terminological information. Since 1985, the field has continued to evolve, primarily propelled by advancements in computer science [2]. Terminologists now benefit from tools and technologies that are increasingly suited to their requirements—more accessible, user-friendly, and efficient.

Theoretical discussions regarding the nature of terms arose subsequently, as practical terminology efforts expanded into specialized fields [2]. The theory of terminology has predominantly evolved from empirical experience and the need to address challenges in linguistic communication. In contrast to semantics, which emphasizes the relationship between words and their meanings, terminology is primarily concerned with the connection between real-world entities and the concepts that represent them [2]. This field is functional, designed not to exist in isolation but to facilitate communication within the realms of science, technology, and professional contexts. Consequently, terminological endeavors necessitate collaboration between subject matter experts and both general and applied terminologists to define and standardize the concepts and terms pertinent to a specific field. It can be best understood as the collection, analysis, organization, and presentation of the terminology of specialized domains, often spanning multiple languages. Its objective is to address genuine communication needs and enhance clarity and efficiency in professional interactions, whether directly or through translators and language standardization entities.

This pragmatic and service-oriented view of terminology aligns with the needs of contemporary society, where practical solutions often take precedence over theoretical reflection. As Guilbert noted, "the essential aim of the terminological lexicon is not the language itself" [2]. Terminology is inherently tied to the generation and use of knowledge and therefore must be understood in its social and functional context. Ultimately, terminology serves the professionals who rely on it as both a tool for communication and a means of structuring and understanding the conceptual foundations of their disciplines. Their interest in standardization stems from this dual role, which involves clearly and consistently linking terms with their respective concepts.

According to Cabré [2], terms are conceptual units that encode knowledge structure, not merely lexical labels for objects. Unlike general vocabulary, whose meanings are often context-dependent and shaped by syntactic usage, terms are understood to possess stable and unambiguous meanings. While ordinary words evolve organically within natural language, terminological units are anticipated to maintain normative and technical significance. In this regard, terms serve as coded representations of scientific concepts, devoid of semantic ambiguity, facilitating cognitive processes and communication within specialized domains. Consequently, the ontological necessity of terms within a language warrants attention.

Terms occupy a pivotal position in scientific, technical, and artistic disciplines, often surpassing the relevance of general vocabulary. The development of a discipline's scientific identity is intricately connected to terminological endeavors, particularly in emerging or less formalized fields. Terms operate as instruments for delineating existing concepts and are integral in the generation of new knowledge [4]. As the breadth of scientific knowledge expands, the necessity to name, classify, and standardize concepts becomes imperative. This necessity has propelled the evolution of terminological systems. Within this context, Sowa [5] posits that specific subsets of terminology can function as effective entry points for formalization. He contends that established terminologies facilitate knowledge transfer and contribute to the logical structuring of concepts, thereby assuming a foundational role in shaping and organizing scientific domains.

### **3. THE EVOLUTION OF INDUSTRIAL DESIGN TERMINOLOGY**

The evolution of industrial design terminology illustrates the dynamic interplay between technological innovation, cultural shifts, and the expanding role of design within society. As the discipline advanced from a function-oriented practice to a multifaceted field centered around human experience, new terminologies emerged to encapsulate evolving priorities and conceptual frameworks. Below is a historical overview emphasizing how key design terms were established and gained prominence.

#### **3.1. Early 20th Century: Functionality and Standardization**

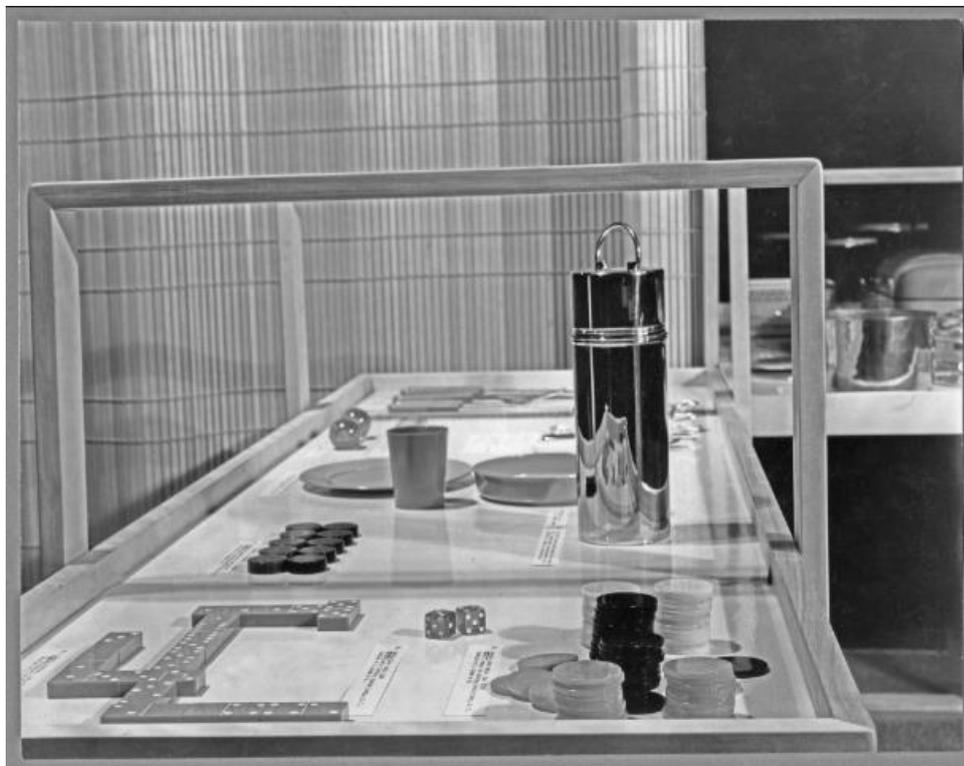
Heskett [6] delineates the emergence of industrial design as a recognized profession and the establishment of its associated language, attributing these developments to the wave of industrialization and the principles of the modern movement at the onset of the 20th century. In a similar vein, design historian De Noblet [7] observes that the conceptual framework of industrial design evolved during the transition from handicrafts to industrial production. In this context, the shift from craft aesthetics to mass production aesthetics in the early stages of the design discipline facilitated the introduction of novel concepts into designers' lexicons [8]. The first half of the 20th century was characterized by the professionalization of industrial design and the institutionalization of its terminology. During this period, the identity of the designer became more defined, educational institutions and organizations started to emerge, and the terminology expanded in tandem with this institutional development. From the early 1900s until the Second World War, concepts such as functionalism and standardization gained prominence in design, coinciding with the ascendance of modernism. This shift was profoundly influenced by the socio-economic transformations brought about by the mature phase of the Industrial Revolution, including the development of mass production capabilities, the rise of consumer markets, and rapid urbanization. The prevailing modernist ideology, with its emphasis on rationality, efficiency, and progress, further legitimized these concepts. The concept of "standardization" in the field originated in the realms of production and engineering, driven by the need for cost-effective manufacturing and the interchangeability of parts, a necessity acutely felt during periods of industrial expansion and wartime production. Conversely, the two fundamental terms of the functionalist approach, "form" and "function," were directly appropriated from the discipline of architecture into industrial design, reflecting a desire to create objects that were not only aesthetically pleasing in their simplicity but also ideally suited to their intended purpose and the new modes of industrial fabrication.

The concept of standardization in mass production originated with Simeon North's introduction of a novel perspective on arms production during the 18th century. To meet the substantial orders he received from the war department, Simeon North devised innovations that were later referred to by Eli Whitney as "interchangeable parts" [9]. Over the years, this concept was formalized into what is now known as standardization. By the 20th century, it had developed into a notion that encompasses not only technical aspects but also broader domains, including quality, safety, environmental considerations, and user experience. The adoption of standardization in industrial design had significant practical implications, compelling designers to consider material properties, manufacturing tolerances, and assembly processes from the outset. This led to the development of design practices centered on efficiency, modularity, and complexity reduction, aiming to make products more accessible and affordable for a broader population.

In contemporary industry, the Ford Model T is extensively recognized as the most distinguished exemplar of the convergence of standardization and mass production. The production revolution instigated by Henry Ford through this model led to a profound transformation not only within the automotive sector but also in the broader methodology of industrial production. The significance of this influence lies in the fact that the term "Fordize" is frequently used in various articles to explain the concept of standardization [9]. This term delineates a production system characterized by mechanization, high volume, rapid production, and low costs. Following its application within the automotive sector, this concept subsequently served as a paradigm for industries such as furniture, electronics, and household appliances, evolving into one of the fundamental criteria within the industrial design process. Initially confined to technical standardization, the concept gradually broadened to include aspects of user experience. The Fordist model not only revolutionized production but also subtly began to shape design thinking toward system-level

considerations, where the product was part of a larger ecosystem of manufacturing, distribution, and eventually, use. This laid an early, albeit indirect, groundwork for later considerations of usability and user-centeredness, even if the primary focus remained on production efficiency. Indeed, the broader discourse surrounding standardization within design theory, extending beyond mere production techniques, was fundamentally initiated by the modernist design approach and its guiding principle, “form follows function.”

In the terminology of industrial design, the concepts of function and form, which serve as the foundations of the modernist design approach and have significantly shaped 20th-century design discourse, hold profound significance [10]. According to Loos [11], the forms found in nature are determined by their functions. Consequently, the necessity for the form to follow function is regarded as a law of nature, and this principle should similarly apply within the realm of architecture. By this law, the architectural form must adhere to its function. This notion resonated throughout industrial design, laying the groundwork for understanding functional aesthetics [6]. The maxim “form follows function” emerged as a guiding principle for designers in architecture and across a diverse array of products, ranging from furniture to electronic devices [12]. During this era, when it was contended that form should be shaped solely by function, aesthetics was exclusively associated with machine production. In MoMA’s bulletin covering the 1940 exhibition *Useful Objects Under Ten Dollars*, McAndrews proposed a set of standards recognizing that such products were not exemplars of fine art and should not be evaluated in aesthetic terms [8]. Refer to Figure 1 for an illustration of an exhibition visual. This redefinition of aesthetics, often termed “machine aesthetics,” had a profound impact on design philosophy, leading to a significant shift in the designer’s focus: away from primarily decorative concerns or emulating handcrafted styles, towards becoming an orchestrator of form and utility derived from industrial processes. Design education, particularly within institutions like the Bauhaus, began to emphasize a rational problem-solving approach, integrating technical knowledge with artistic principles, and promoting an aesthetic sensibility derived from the inherent qualities of materials and manufacturing processes, rather than relying on applied ornamentation.



**Figure 1.** Image From The Exhibition – Source: MoMA [13]

Indeed, the Deutscher Werkbund movement, founded in Germany in 1907, and subsequently the Bauhaus school, established in 1919, adopted an educational program that combined art and technology while emphasizing functional and simple design [14]. In the Bauhaus Manifesto, Walter Gropius sought to integrate the functional thinking necessary for industrial production with aesthetic education [15]. László Moholy-Nagy, by centralizing the harmony of form and function in design education, advocated for a close relationship between visual composition and intended use [16]. The modernist paradigm's function dominated design practice until the mid-20th century. Particularly following World War II, industrial designers in Europe and America ascribed great significance to creating practical designs that were easy to manufacture and devoid of unnecessary ornamentation [17].

The concept of standardization, which focused on objects in early modernism, gradually expanded to encompass the human element within production processes. The belief that every movement in the workplace should be grounded in mathematical and scientific principles paved the way for efforts to increase worker productivity. The emergence of concepts such as human factors and ergonomics during this period can also be traced to modernist thought. In this context, ergonomics first emerged within a framework that prioritized physical efficiency while marginalizing worker health, reflecting a utilitarian and mechanistic approach to labor.

### 3.2. Mid-20th Century: Ergonomics

In written texts, the application of ergonomic design can be traced back to the 4th century BC, with Hippocrates' creation of a surgeon's chair exemplifying one of the earliest instances of ergonomic design [18]. Hippocrates' work titled "In The Surgery" presents specific recommendations regarding the posture a physician should adopt to ensure comfort during surgical procedures [18]: "As for himself when seated, his feet should be aligned in a perpendicular line to the knees and brought together slightly with a small gap. The knees should be slightly higher than the groin and spaced enough to support the elbows and leave room for them."

The emergence of ergonomics, in its contemporary understanding, can be traced back to the 19th century. In this period, the rapid mechanization of production during the Industrial Revolution introduced significant challenges for workers, compelling them to adapt to the often repetitive and physically demanding conditions of the factory line. In response, the concept of "human factors" emerged in academic literature as an approach to enhance worker productivity. Behavioral scientists undertook research addressing these challenges, which were historically referred to as human engineering or human factors engineering [19]. Before World War I, Taylorism—characterized as the scientific analysis of workers—was introduced to enhance human efficiency within the workplace [20]. While aiming for increased output, Taylorism often viewed the worker through a mechanistic lens; however, it also pioneered systematic approaches to work analysis. Subsequently, Frank and Lillian Gilbreth, students of Taylor, established the foundational principles for what is currently termed time-and-motion study through their detailed analyses of tasks such as bricklaying and surgical procedures. They devised methods for quantifying work elements based on micro-level bodily movements; this technique remains integral to modern industrial engineering [21]. During World War I, human errors in pilot cabins, radar systems, and control panels resulted in significant consequences, starkly demonstrating that human performance, not just machine capability, was a critical determinant of system success and safety. This facilitated the evolution of this concept into a recognized modern discipline [8]. Human factors engineering was developed through examining static and dynamic anthropometry and exploring the interactions between humans and human-made objects [8]. The necessity for enlisting large numbers of men into the armed forces and allocating them to diverse specialized roles rendered the development of both intelligence tests and specialized aptitude tests imperative. Although the experiences during World War I contributed minimally to the human factors testing methodologies acknowledged today, they provided a novel insight into individual differences and how these variances could influence performance efficiency, subtly challenging purely standardized approaches to human work [19].

The term "ergonomics" was first introduced in 1857 by the Polish scientist Wojciech Jastrzębowski in the article titled "*An Outline of Ergonomics*" [22]. In this context, ergonomics is a scientific discipline that

examines the harmonious interaction between humans and nature. While Jastrzębowski's framing was broad in scope, encompassing natural harmony, the modern understanding of ergonomics has become more focused on optimizing the interaction between humans and designed systems. The distinction between ergonomics and human factors engineering can be elucidated by examining how these concepts are defined and the emphasis placed on efficiency or the individual human being. Ergonomics traditionally emphasizes the physical fit between human bodies and tools, while human factors expand this focus to include cognitive processes and user behavior. The perspective that humans should adapt to machinery gradually transitioned to the recognition that machinery must adapt to human needs. For the first time during World War II, technology and human sciences collaborated systematically and in a coordinated manner. A diverse group of professionals, including physiologists, psychologists, anthropologists, medical doctors, and engineers, converged to address the challenges arising from the interaction between humans and complex military equipment, thereby leading to the institutionalization of ergonomics as a field. This wartime collaboration was pivotal, establishing ergonomics as a scientifically grounded design discipline. It necessitated the systematic application of data from the human sciences to design problems, transforming design practice from an often intuitive process to one informed by empirical research on human capabilities. This, in turn, began to reshape design education, demanding a more interdisciplinary curriculum. It has since been acknowledged as an interdisciplinary scientific field [23]. The successful outcomes of this multidisciplinary cooperation ensured the continued application of the ergonomic approach in the postwar industry, as knowledge gained in military contexts was transferred to the design of consumer and industrial products for a burgeoning mass market. The rise of mass consumption from the 1930s onward further propelled this, as considerations of usability and safety became significant criteria for industrial design in an increasingly competitive marketplace. According to Krippendorff (2005), ergonomics reflects the functionalist design ideal. On the contrary, Heskett [24] contends that when the alignment between an object and its user is paramount, ergonomic analysis informed by data regarding human dimensions becomes critically essential for assessing the appropriateness of a form for the intended user [24]. These perspectives suggest that ergonomics did not simply replace functionalism but rather redefined it, proposing that actual functionality must encompass human compatibility and well-being, effectively extending the maxim to "form follows function and human factors."

In the realm of industrial design, the principles of ergonomics were initially incorporated into the development of various products, including furniture, office equipment, automobiles, and household goods. Henry Dreyfuss is recognized for his substantial interest in ergonomics, serving as both a theorist and a practitioner within the field of industrial design. In his publication, "Designing for People" [25], he emphasizes the responsibilities of industrial design, particularly in terms of functionality, usability, and ethical considerations. He provides recommendations for integrating ergonomic principles into mass production processes. In the book above, he elucidates the necessity of considering diverse human dimensions in design, employing two hypothetical user models he designated "Joe" and "Josephine." Dreyfuss's collaboration with Bell Laboratories represents one of the earliest instances of systematic ergonomic industrial design. Notably, the Western Electric Model 302 Telephone stands out as one of the pioneering technological consumer products documented in the annals of ergonomics (see Figure 2). Dreyfuss's work was instrumental in popularizing ergonomic thinking within commercial industrial design, demonstrating its value beyond specialized military or industrial applications. His human-centered design philosophy, which considered diverse user needs and ethical responsibilities, significantly influenced how designers approached product development for mass markets.



**Figure 2.** Model 302 – Henry Dreyfuss ve Bell Labs 1937-1955 [26]

Another significant example of ergonomic analysis in industrial design is the Herman Miller “Aeron” chair. The Aeron chair, meticulously designed for Herman Miller, was created with careful consideration of ergonomic data, focusing on the most minute details [24]. The commercial success and cultural impact of products like the Aeron chair consolidated the importance of ergonomic principles in contemporary design. However, while these achievements primarily addressed physical ergonomics, the rapid proliferation of information technologies and increasingly complex interactive systems in the latter half of the 20th century revealed an imperative for a deeper understanding of human cognitive processes, facilitating the emergence of usability and user experience as distinct yet interrelated domains of inquiry.



**Figure 3.** Aeron Chair – 1992 – Source: MoMA [27]

In its early applications, ergonomics was primarily concerned with physical ergonomics and biomechanical efficiency, focusing on bodily fit, posture, and task performance, while largely overlooking human cognitive processes and emotional responses. The design grounded in anthropometric

data, struggled to move beyond the assumption of a standardized human body, often neglecting the broader social, cultural, and environmental dimensions of design. However, the widespread adoption of information technologies in the latter half of the 20th century introduced new cognitive demands, indicating the necessity for a deeper understanding of mental processes. This shift laid the foundation for the emergence of interrelated research fields such as usability and user experience, which expanded the scope of ergonomic inquiry beyond physical parameters.

### **3.3. Mid-20th Century: Usability and User Experience**

Over the years, classical ergonomics has evolved successfully, with a primary focus on designing hardware interfaces. However, in the future, information technology systems will increasingly depend on software and software interfaces to define the system's usability and user-friendliness [28]. Consequently, alongside physical ergonomics, a pressing need exists for substantial advancements in what has come to be recognized as "Cognitive Ergonomics." Cognitive Ergonomics refers to the systematic study, measurement, analysis, and modeling of human cognitive behavior about advanced technological systems. Given the extensive individual differences among system users—including intelligence, experience, memory, and motivation—the variability involved is anticipated to surpass that encountered in physical ergonomics [28]. This recognition marked a crucial shift, demonstrating that effective human-machine interaction hinged not only on physical fit but increasingly on understanding and supporting human cognitive processes, thereby establishing critical foundational principles for the later concepts of usability and user experience in complex systems, as purely physical approaches proved insufficient for the mental demands of emerging technologies.

During the Second World War, the Aero Medical Laboratory received a request from the Air Force to investigate the cause of a recurring error made by pilots and co-pilots during landing operations: retracting the landing flaps instead of the landing gear [29]. This issue was not comprehensively documented until several years later, in 1947, by Fitts and Jones:

"I remember reading dozens of accident reports that concluded these accidents were caused by 'pilot error'. What I found while examining the cockpits of aircraft like the B-17, the flying fortress of those years, was two identical toggle switches side by side - one for the landing gear and one for the landing flaps. Given the stress of landing after a combat mission, it's understandable how these could easily be confused. I called it a designer error, not a pilot error. The specific solutions proposed at the time (separating controls and/or shape coding) were later supported by findings in the human factors literature. Another solution was more mechanical: installing a sensor on the landing struts to detect whether the weight of the airplane compressed them. If they were compressed, a circuit would disable the landing gear control in the cockpit."

Chapanis [30] expresses his first observations on cognitive ergonomics as follows:

"During the war, our machines became so complex that in recent years we have had to start a new branch of technology: this activity, called human engineering, represents a new beginning in the application of psychological principles to industry."



*Figure 4. Instrument Panel of B-25 [30]*

Chapanis's observations, born from the crucible of wartime necessity, underscored a pivotal realization: as technology advanced, the bottleneck for system performance became increasingly human rather than mechanical. This understanding, initially critical in military and aviation contexts, was gradually integrated into industrial design as computational technologies began to permeate civilian and commercial spheres. By the late 1950s, the potential of computers within the industrial and business sectors was widely acknowledged, leading to the development of the first commercially viable machines, designed by computer specialists for data processing professionals. Commencing in the mid-1960s, the advent of minicomputers and remote terminal access to shared mainframes facilitated the integration of computers into users' daily lives. Nevertheless, the challenges encountered by non-specialists and the complexities associated with human-computer interaction were already becoming evident [28]. With the introduction of the microcomputer in 1978, and particularly following its widespread adoption post-1980, computers began to cater to a more diverse audience, including bank clerks, business executives, librarians, insurance agents, secretaries, stockbrokers, and even astronauts. This rapid expansion in computing capabilities led to increased usability challenges. Users transitioned from primarily computing professionals to voluntary participants [31]. Consequently, designers ceased to be representative of the average user. However, they may not have been fully aware of how distinct and unrepresentative they had become [28].

Similar to ergonomics, usability, which is fundamentally linked to human factors engineering, is semantically related to ergonomics. Initially, ergonomics was associated with anthropometry within the field of human factors and subsequently expanded to encompass psychology, particularly in the context of "human-machine interaction." In contrast, usability is defined from the user's perspective in terms of its components: effectiveness, efficiency, and satisfaction [32]. While rooted in the principles of ergonomics, usability broadened the scope beyond physical comfort and safety to systematically address the cognitive demands and ease with which users could learn, operate, and accomplish their objectives with a product, especially in light of the escalating complexity of interactive systems. This represented a significant expansion of the scope of design inquiry, extending its focus from the 'body' of the user to include the 'mind' as well.

The role of human factors in various phases of the design process, as well as the most effective methods for assisting designers in creating usable designs, has been explored intuitively and through empirical research over many years. Meister and Farr (1967) underscored several challenges that designers encounter when applying human factors knowledge to the design process, leading to the development of numerous manuals and textbooks that focus on general ergonomics within the context of broader systems [28]. The concept became central to design literature during the 1980s. Theorists such as Nielsen define usability as "the degree to which specific users can achieve specific goals effectively, efficiently, and satisfactorily," positioning the term directly within industrial design terminology and devising

measurement methods for it [33]. Usability testing has become a standard stage in industrial design, where real users evaluate prototype products and gather ergonomic and usability data [34]. The integration of direct user feedback into the design cycle, often involving methods such as think-aloud protocols, heuristic evaluations, and persona development, has fundamentally altered design practice. These developments catalyzed the creation of discourses such as “user-centered design” and “human-centered design” in design theory. The integration of ergonomics and, subsequently, usability concepts into the field represented a significant turning point in the evolution of industrial design toward a human-centered approach, recasting the designer's role increasingly as an advocate for the user. Consequently, the limitations of the human body and mind have been incorporated into discussions within the field concerning function and form. With the incorporation of “human factors” into the design process, designers are prompted to regard products not merely as technical objects, but as tools that facilitate human experiences [35]. The conceptual framework provided by ergonomics has enriched design terminology with terms such as comfort, safety, usability, and adaptability [36]. This transformation also lays the groundwork for the concept of user experience, which emerges in the later stages of industrial design and establishes a foundation for a culture that prioritizes the human element in design. Particularly with the integration of information technologies and digital products into daily life, a new concept has rapidly gained prominence in industrial design terminology: user experience. User experience encompasses a comprehensive consideration of a user's interaction with a product, system, or service [37]. This includes not only physical ergonomics or usability (the 'can do' aspect), but also the emotions a user experiences, brand perception, and all impressions garnered throughout the interaction process (the 'feel and mean' aspect) [35]. The prominence of this concept in design literature is intricately connected to advancements in the field of human-computer interaction during the 1990s. Notably, with the widespread adoption of personal computers, software, and the internet, designers began to construct physical objects and dynamic interactive systems [38]. This transformation has contributed to the growing significance of the user concept and the recognition of experience as a key output of design. Consequently, design education began to incorporate methodologies from human-computer interaction, cognitive psychology, and user research to equip designers with the skills to create not only functional but also truly usable and engaging experiences.

Several important disciplines have contributed to the integration of the concept of user experience into the design language, including cognitive psychology, human-computer interaction, and marketing and consumer behavior. Cognitive psychology offers scientific insights regarding which information should be emphasized in interface design. It elucidates how a product should facilitate users during their initial interactions by deepening our understanding of mental processes, such as perception, learning, and memory [39]. The discipline of human-computer interaction is foundational in developing usability principles and interface design patterns for interactions with computer systems [40]. Terms like “graphical user interface,” “menu hierarchy,” and “feedback” have become part of the design vocabulary through this discipline [40]. Conversely, marketing and consumer behavior focus on user satisfaction, brand loyalty, and emotional design, illustrating that design should forge experiences that are not only functional but also pleasurable and engaging [41]. Donald Norman, a well-regarded cognitive scientist, gained prominence for his analysis of user interactions with products during the late 1980s and early 1990s. At Apple, he popularized the term “user experience” among a wider audience. In a collaborative paper with Henderson [42], Norman articulated a vision of user experience in design that transcended the confines of “human-computer interface” and “usability,” encompassing the emotional and holistic dimensions of product usage. In his book *The Invisible Computer* [43], Norman emphasized that the success of technological products should be evaluated not solely on functional performance but also on the comprehensive experience afforded to the user, thereby systematically formalizing the user-centered design approach. Within this framework, designers are expected to cultivate a profound understanding of the end user's needs, expectations, and constraints and integrate user feedback and usage scenarios throughout the design process [44].

The concept of user experience extends to various subterms within industrial design terminology, including interaction design, service design, and experience design [38]. “Interaction design” refers to the design of reciprocal actions between the user and the product, such as pressing a button and the device's subsequent response. In contrast, “service design” seeks to ensure that services associated with a product

are coherent and satisfactory for the user [45]. The term “experience design” occasionally extends beyond physical products, referring instead to the creation of user experiences across various spaces, events, or digital environments [46]. By the late 1990s and early 2000s, user experience design materialized as a distinct area of expertise. The ISO 9241-210 standard, published in 2000, outlined user-centered design processes, emphasizing the importance of usability and user experience criteria in a product’s success [47]. According to the ISO definition, user experience encompasses all perceptions and responses resulting from a user’s interaction with a system, including usability, ergonomics, and emotional satisfaction [47]. This standard rendered user experience a measurable and manageable objective for designers and corporations alike. Concurrently, academic discourse regarding user experience also increased. Hassenzahl and Tractinsky [37] underscored that user experience involves not only the efficient completion of tasks but also the creation of lasting impressions and emotional impacts on the user, advocating that design research should extend beyond mere usability (Hassenzahl & Tractinsky, 2006, p. 92). Their contributions expanded the understanding of user experience within the literature, emphasizing that dimensions such as “pleasure,” “emotion,” and “aesthetic impact” should also constitute areas of inquiry [37].

### **3.4. Late 20th Century: From Functional Aesthetics to Emotional Aesthetics**

The concept of emotional aesthetics centers on the notion that design objects should be evaluated based on their utility value and the emotions they evoke in the user. While the significance of emotions in aesthetic theory was historically contested by philosophers such as Baumgarten and Kant during the 18th and 19th centuries [48], the systematic examination of emotions within the realm of industrial design is a relatively recent innovation. From the mid-20th century onwards, psychology has begun to explore the association between emotions and cognitive processes, with psychologists such as Paul Ekman [49] and Robert Plutchik [50] categorizing basic emotions. This accumulation of knowledge within psychology established a foundational basis for research on user experience in design. In contemporary terms, the concept of emotions in product design began to take shape at the conclusion of the 1970s in Japan with the introduction of the Kansei Engineering approach. In the 1980s, Mitsuo Nagamachi integrated the concept of kansei, which translates to “emotion” or “sensitivity” in Japanese, with engineering, applying it to product development [51]. Nagamachi (1989) defined Kansei Engineering as the translation of consumer sentiments and perceptions concerning a product into design elements [51]. Consequently, the notion that emotional responses could be harnessed within the design process initially arose within engineering.

With the emergence of user-centered design during the 1980s and 1990s [52], the sensory and emotional impacts of products began to gain prominence. Following Donald A. Norman’s application of cognitive psychology principles to design challenges, by the late 1990s, design researchers started to expand the concept of user experience to encompass the emotional resonance of products. In 1999, the inaugural international “Design and Emotion” conference was organized, signifying the establishment of an academic community within this domain [53]. Norman further advanced this movement with his 2004 publication, *Emotional Design* [54]. In this work, Norman analyzes human-product interaction across three tiers: the visceral level (the emotional response upon initial observation, aesthetic appeal), the behavioral level (the pleasure or frustration experienced during usage), and the reflective level (assessing the relationship with the product over time, attributing meaning and value) [54]. Norman’s contributions instigated a discursive shift by underscoring the significance of an “emotion-focused” design approach in industrial design practice. Today, among the criteria for effective design, in addition to functionality, ergonomics, and usability, the user’s emotional response to the product is also recognized [54]. This transformation represented a notable departure from the modernist paradigm.

In conjunction with this transformation in design discourse, novel approaches have emerged in practice. Patrick W. Jordan, through the New Human Factors approach, identified four fundamental categories of pleasure in product design focused on user satisfaction: physiological pleasure (sensory enjoyment), sociological pleasure (satisfaction derived from social interaction and status), psychological pleasure (pleasure from cognitive and emotional responses), and ideological pleasure (satisfaction from the alignment of the product with the user’s values) [41]. Drawing inspiration from anthropologist Lionel

Tiger's theory of "four pleasures," Jordan [41] established this classification. He introduced the concept of "pleasurable design" into the discourse, extending beyond mere usability in industrial design [41]. In the early 2000s, researchers such as Pieter Desmet experimentally demonstrated that products could evoke specific emotions. They proposed the Product Emotion model, arguing that design can be strategically crafted to elicit particular emotions in users, including happiness, surprise, or pride [55]. During this era, user experience evolved to include emotional experience, and "design and emotion" themes began to be integrated into industrial design educational curricula [53]. This integration catalyzed a transformation in design pedagogy, prompting students to explore narrative structures, sensory engagement, and the symbolic meanings embedded in objects. Practically, designers began to employ advanced methods such as emotion mapping, storytelling, and co-creation techniques to strategically design for intended emotional responses [56]. Consequently, the purpose of design was redefined not only as achieving functional satisfaction but also as fostering an emotional connection and a positive user experience.

The design approach developed around emotional aesthetics is exemplified in numerous iconic products. For instance, the Juicy Salif lemon squeezer, created by Philippe Starck in 1990, diverged from the conventional typology of kitchen tools and transformed into an object that elicits surprise and delight through its sculptural form (see Figure 5). Starck's design achieved recognition not for its practicality. Still, for the emotional response and conversational value it evoked, it was selected as the cover image for Norman's book on Emotional Design [54]. This product serves as a pioneering and notable example of the intentional application of emotional aesthetics in industrial design, demonstrating a deliberate prioritization of emotional impact and symbolic value over purely utilitarian concerns—a tension often debated within design discourse.



**Figure 5.** Juicy Saliff – Philippe Starck – Source: Alessi [57]

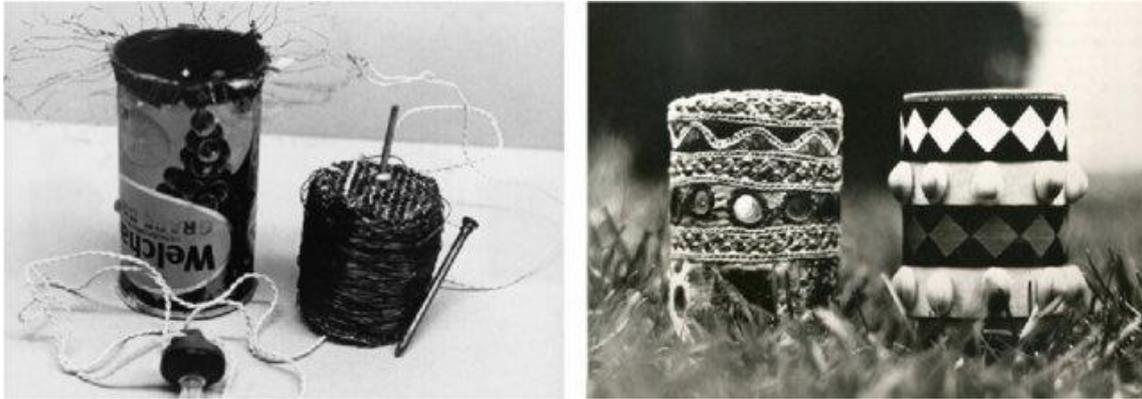
According to Heskett [24], this approach unlocks a landscape of limitless possibilities for generating ever-new forms that require little or no connection to purpose. It enables products to be drawn into fashion-driven cycles of change for the primary benefit of producers, turning design into a kind of fashion instrument across many industries. This attitude toward design was eagerly adopted by numerous companies—such as Alessi—that sought to add value to products with low profit margins [24]. As

consumption shifted from merely meeting functional needs to addressing individual gratification through emotional design and identity construction, design became one of the driving forces of capitalist economies from the mid-20th century onward. It was precisely the ecological crisis triggered by this pleasure-oriented culture of consumption that laid the groundwork for the emergence of the sustainable design paradigm. Jonathan Chapman [58] introduces the concept of emotionally durable design. He argues that fostering emotional longevity between users and objects is critical from a sustainable design perspective. According to Chapman, emotional aesthetics should not merely be about fleeting pleasure but about creating long-term satisfaction and attachment, thereby potentially extending product lifespans and reducing waste [58]. This perspective suggests that the depth of emotional connection can be a key factor in more sustainable consumption patterns, a theme that resonates strongly with subsequent discussions on sustainable design.

### **3.5. Late 20th Century: Sustainable Design**

The concept of sustainability is fundamentally rooted in the global rise in environmental awareness and the ecological movement that emerged during the latter half of the twentieth century. Significant developments, such as the oil crisis of the 1970s and the "Limits to Growth" report (1972), illuminated the fact that unlimited economic growth and consumption were unsustainable [59]. The first prominent use of the term "sustainability" was noted in the 1987 report "Our Common Future" issued by the United Nations World Commission on Environment and Development. This report brought the concept of sustainable development to the global agenda, defining it as the ability to meet the needs of the present without compromising the capability of future generations to meet their own needs [60]. Sustainability is inherently a multidisciplinary concept, grounded in the fields of ecology, environmental science, economics, and ethics. The origins of sustainability within industrial design can be traced back to the mid-twentieth century. In the 1960s, Buckminster Fuller drew attention to the Earth's limited resources through his metaphor of "Spaceship Earth" [61]. Meanwhile, industrial design theorists, such as Victor Papanek, began to question the social and environmental responsibilities associated with design from the late 1960s onward. Victor Papanek is regarded as one of the pioneering figures emphasizing the ethical and ecological dimensions of the industrial design profession [62]. In the preface to his 1971 book "Design for the Real World," Papanek posited that industrial design was one of the most detrimental professions humanity might encounter [62] and paved the way for ethical and sustainable approaches to emerge in design education and practice following 1970 [63]. Even at that time, Papanek addressed issues such as manufacturing radios from recycled materials and designing low-cost products for individuals with disabilities and those of low income, presenting early instances of socially and environmentally conscious design [62]. Papanek's radical critique and proactive proposals had a profound impact on design philosophy, challenging the prevailing consumerist ethos and positing the designer as a responsible agent capable of addressing pressing global issues, particularly through the promotion of socially responsible and ecologically sensitive design approaches [62]. His work catalyzed a shift in design education, moving it towards the incorporation of ethics, social responsibility, and ecological literacy into curricula. It inspired practical approaches centered on appropriate technology, resource conservation, and designing for real human needs rather than manufactured desires. During this era, Manzini [64] emphasized the need to develop systematic strategies for reducing the environmental impact of industrial production. Dieter Rams (1987) bolstered this transformation by incorporating the principle of "environmental friendliness" into the criteria for good design. By the late 1970s and into the 1980s, terms such as environmental design, green design, eco-design, and cradle-to-cradle design began to permeate design terminology [65]. While until the 1990s the success of designers was predominantly assessed based on aesthetics and market performance, criteria such as a product's carbon footprint, energy consumption, and material toxicity also began to be regarded as integral components of design quality during the 1990s and 2000s [66]. This shift catalyzed transformative changes in design practice, including the systematic adoption of tools such as Life Cycle Assessment (LCA), a heightened emphasis on materials science aimed at developing sustainable alternatives, and the formulation of strategies under the 'Design for Environment' (DfE) framework, encompassing principles like dematerialization, detoxification, and design for disassembly and recyclability [66].

Examples of products that embody sustainability principles span various periods in design history. A notable early example is the tin can radio prototype, developed in the 1970s by Victor Papanek and James Hennessey (see Figure 6) [67]. This radio, constructed using simple and recycled components, such as a tin can casing and a basic electronic circuit powered by candlelight, sought to address the communication needs of rural populations in developing countries at a minimal cost. This design represented a pioneering project that integrated the social dimension of sustainability, reflecting Papanek's design philosophy.



*Figure 6. Tin Can Radio (1962) by Victor Papanek and George Seegers, and the radio decorated by an Indonesian user (Marotta et al., 2021) [67]*

Another example previously referenced in the ergonomics section is the Aeron Chair, introduced by Herman Miller in 1994 (see Figure 3). This chair distinguishes itself not only through its ergonomic design but also because 94% of its components are recyclable and is characterized by a durable construction. Rather than utilizing foam and PVC, which are commonly found in traditional office chairs, the Aeron Chair incorporates a stretchable mesh material known as Pellicle. This innovation enhances user comfort while facilitating component replacement, and its design has become one of the first commercial furniture products to achieve Cradle to Cradle certification [68]. The evolution towards sustainable design, as exemplified by Papanek's activism and products like the Aeron Chair, not only redefined technical and material considerations but also underscored a broader shift in understanding the designer's role and responsibility within society. This growing awareness of design's far-reaching impacts naturally led to questions about who should be involved in making these critical design decisions, thereby fostering an environment conducive to the emergence of participatory design approaches where users and other stakeholders are actively engaged in shaping more equitable and sustainable futures.

### **3.6. Late 20th Century: Participatory Design**

Participatory design is based on the principle that stakeholders actively and creatively engage in the design process. The origins of this concept can be traced back to the late 1960s and early 1970s, predominantly grounded in the democratic participation movements within Scandinavian nations. By the end of the 1960s, Scandinavian labor unions, in their pursuit of improved working conditions and the promotion of industrial democracy, expressed a desire to influence the implementation of new technologies within workplaces [69] [70]. Notably, in Norway during the early 1970s, the notion emerged that workers and unions should participate in decision-making processes when designing computer-supported work systems [70]. In this respect, the "Democratic Design" experiments in Norway can be regarded as among the first instances of participatory design [70]. Concurrently, during the same period in the United Kingdom, the Design Research Society convened a conference titled "Design Participation" in Manchester in 1971, thereby elevating the issue of user participation to a prominent position within the international design community [71]. These early developments underscored a fundamental philosophical shift: a move towards democratizing design processes and acknowledging the rights and expertise of those directly affected by design outcomes.

However, the comprehensive integration of participatory design into the industrial design discipline, both as a theoretical concept and a practical method, took place during the 1990s and 2000s [72]. Initially, the

focus was predominantly on the collaborative design of information systems and software interfaces; however, participatory design gradually extended to encompass various scales and fields, including product design, service design, and public space design. By the 2000s, particularly in the United States and other nations, participatory design increasingly emerged as a method for innovation and the enhancement of user experience [73]. During this timeframe, large design consulting firms sought to mitigate product development risks and identify more accurate responses to user needs by incorporating end users into the design process. Liz Sanders articulated this trend as the “from user to design partner” paradigm, underscoring the necessity for authentic creative participation, which contrasts with traditional user research methods [74]. Nonetheless, it cannot be asserted that the fully realized participatory design process has been extensively reflected in design practice.

One of the most notable instances illustrating the impact of participatory design on practice is evident on the IKEA Hackers platform, where users modify products to meet their specific needs [75]. On these digital platforms, individuals creatively recombine IKEA furniture for diverse applications and share the innovative solutions they create with others, signifying a form of engagement not initially contemplated by the designer. Notably, in 2021, IKEA initiated the publication of official “hack” guides for select products, thereby integrating user creativity into the institutional design framework. The rise of participatory design, therefore, represents a culmination of many of the trends discussed previously – from a focus on the human user (ergonomics, usability, user experience) to an engagement with broader social and ethical responsibilities (sustainability). It signifies a maturation of the design discipline, where the definition of “designer” expands and the boundaries between producer and consumer become increasingly blurred. This ongoing evolution in industrial design terminology, reflecting a continuous redefinition of design's scope, purpose, and methods, sets the stage for a concluding discussion on the discipline's multifaceted and ever-transforming nature.

#### **4. CONCLUSION**

The process of forming industrial design terminology transcends the mere establishment of a linguistic structure isolated within the design discipline; instead, it constitutes a dynamic and multilayered framework influenced by numerous fields. As this study has clarified, this framework does not serve as a passive reflection of disciplinary evolution, but rather as an active arena for cross-disciplinary conceptual appropriation and recontextualization, wherein terms are borrowed, adapted, and infused with new meanings that redefine the evolving concerns and identity of design. Fields such as engineering, architecture, art, sociology, psychology, ergonomics, and marketing have significantly impacted both the conceptual framework and the practical implementation of industrial design. This interdisciplinary interaction has enriched the terminology and advanced its development through a cross-disciplinary understanding, illustrating that industrial design operates as a critical nexus where diverse intellectual traditions converge and are synthesized.

An examination of example terms reveals a distinct evolutionary trajectory: technical terminology appropriated from engineering predominantly emphasizes the functionality of the designed artifact, while concepts evolved from psychology and sociology place the human user at the center. Engineering-based approaches in industrial design focus on the functionality, manufacturability, and performance of products. In its early era, industrial design occupied a position of synthesizing art and engineering. As noted by the Industrial Designers Society of America (IDSA), “early industrial designers frequently worked on the border between artist and engineer, balancing aesthetics with function” [76]. Terms acquired from engineering—such as durability, cost, efficiency, modularity, and standardization—underscore the “industrial” dimension of design. From the 1950s onward, a significant shift occurred as the focus of industrial designers increasingly shifted toward the user. Within the concept of usability, terms such as perception and cognitive load, borrowed from psychology, have come into use. During this era, industrial designers also integrated human ergonomics, material innovations, and corporate branding into the design process [76]. This shift introduced psychological notions such as user experience, sensory design, and emotional attachment into the terminological repertoire. Consequently, terms such as cognitive ergonomics and user experience have become integral to the lexicon. While sociology and psychology introduced user behaviors and cultural contexts into the terminology, marketing contributed

to the emergence of new concepts by emphasizing the product's economic value and its relationship with the consumer. This entire terminological progression is not merely an academic exercise; it reflects a fundamental transformation in industrial design's self-perception and societal role – from a primarily technically oriented profession focused on mass production to an increasingly human-centered, and later, experience-driven discipline concerned with meaning, interaction, and broader systemic impacts.

Sociology, anthropology, and marketing have contributed terminologies that underscore the societal significance of products and illuminate consumer behavior. Perspectives from social sciences have facilitated the development of concepts such as user research, cultural context, and social impact. Concurrently, the contributions from the marketing discipline reflect the direct commercial dimension of the field, enabling the integration of marketing terminologies such as product life cycle, brand identity, and target market into the terminology used in industrial design. The Industrial Designers Society of America (IDSA) also emphasizes that contemporary industrial designers take into account factors such as corporate branding and end-user benefits [76]. The amalgamation of these diverse terminologies signifies the maturation of industrial design beyond a purely product-centric focus, recognizing its profound embeddedness within, and reciprocal influence on, broader social, cultural, and economic systems.

Ultimately, the terminology of industrial design functions as a discursive instrument that articulates the multidimensional relationships among objects, users, society, and the marketplace. This highlights the inherently interdisciplinary nature and continuously evolving structure of industrial design. The interplay that underlies the formation of this terminology not only directly influences design processes by providing a conceptual scaffold for thought and action but also facilitates the establishment of a shared language for professional communication. In doing so, it actively constructs and negotiates the very identity and boundaries of the discipline. It offers a living and evolving conceptual infrastructure, enriched by the cumulative knowledge of diverse disciplines. Understanding this dynamic terminological landscape is, therefore, crucial not only for tracing the historical trajectory of industrial design but also for critically navigating its present complexities and anticipating its future directions. As new societal challenges and technological frontiers arise, the lexicon of design will undoubtedly continue to adapt and expand, reflecting the discipline's enduring capacity for critical reflection and transformative action.

Industrial design, a discipline that has historically evolved through close interaction with architecture, engineering, the arts, and the social sciences—and whose conceptual lexicon has accordingly broadened [77]—is expected to enter a new phase of transformation in the 21st century, particularly as artificial intelligence technologies become increasingly embedded in design processes. In this context, the trajectory of terminological evolution in industrial design is beginning to be shaped by emerging technologies such as artificial intelligence, digital fabrication, and computational design. The algorithmization of design tools has introduced a new conceptual vocabulary—encompassing terms like data-informed design, generative systems, and AI-mediated creativity—reflecting a shift in both the epistemological and methodological orientation of design practice. Such a shift reconfigures both the practical and conceptual dimensions of design, redefining the designer's role as that of a systemic mediator—one who constructs frameworks to navigate and structure the dynamic interplay among users, machines, and data flows. Within this framework, design emerges not solely as a process of creation, but as a critical practice involving ethical judgment and the construction of complex systems [78]. The integration of big data into design practice has catalyzed the development of novel epistemological frameworks, including data-informed and data-centric design methodologies [79]. The integration of AI into decision-making processes requires algorithms to be ethically accountable, which in turn has introduced new terminology such as transparency and algorithmic justice into the discourse [80].

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