Understanding Person-Environment Relationships as Criteria to Support the Operationalization of Universal Design*ing*

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Abstract. To reach a broader understanding of person-environment relationships as building blocks for universal design in research and practice, this paper combine and discuss three types of interaction between individuals and environments – instrumental, non-instrumental, and non-physical - and five constituent concepts, i.e. accessibility, usability, aesthetic experience, the experience of meaning and emotional experience. Theoretical frameworks/models for person-environment relationships are synthesized and combined based on a literature review and the author's previous experiences. The author proposes to classify accessibility and usability as instrumental person-environment interaction, aesthetic experience as non-instrumental interaction, and experience of meaning and emotional experience as non-physical interaction. At the same time, acknowledge the potential of the three types of interaction to embed cues and choices to accommodate the widest variety and number of people throughout their lifespans. This paper contributes to understanding person-environment relationships as criteria to support research strategies and the operationalization of universal design*ing*.

Keywords. Accessibility, usability, aesthetics, meaning, emotion

1. Introduction

Universal Design (UD) can be thought of as an approach to the practice of design *"... to accommodate the widest variety and number of people throughout their lifespans"* [1]. In other words, universal design*ing* [2] is a process of embedding cues and choices for as many people as possible into products such as environments, goods, objects, programs, and services (further referred to as environments) to improve human performance, health and wellbeing, independence, and social participation [3]. UD is also known as Inclusive Design and Design for All – terms with some differences regarding historical, professional, and political inception, but, showing large similarities regarding human-centeredness, ideology, praxis, and implementation [4,5].

In general, design has increasingly moved toward answering human needs [4]. Considering P-E relationships in design processes represents a step away from the perspective that quality exists as properties in the environments themselves and closer to an approach in which value is added when individuals interact with and live in

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environments. For this paper, a person-environment (P-E) relationship is defined as the outcome of the interaction between the individual and the environment.

Individuals include those who access, use, and experience the environment, those who operate the environment, and those who support the environment. The individual can be the primary user, (i.e. direct hands-on user), the secondary user (i.e. indirect user interacting through a mediator), and the tertiary user (i.e. individual affected by the environment) [6]. Adding to this, the basic starting point for UD is to consider human diversity. During the life course, not least, the ageing process involves increased diversity in terms of functional capacity, past experiences, resources, and expectations since older adults are far from a homogeneous collective.

To better understand the complexities of UD and to reach cross-boundary consciousness about the interactions between individuals and environments, this paper suggests combining concepts of P-E relationships as criteria to support the operationalization of universal design*ing*.

2. Method

In this paper, theoretical P-E frameworks and models are synthesized and combined to suggest a compilation of P-E relationship concepts for a broader understanding of interactions between individuals and environments. The paper is based on a literature review and the author's previous experiences. Primarily, two frameworks are used – Lawton and Nahemow's [7] competence-press model, a theory describing relationships between individual factors and factors related to the environment, and – Desmet and Hekkert's [8] general framework of product experience that applies to all affective responses in human-environment interaction.

In this paper, environments primarily refer to physical environments. Factors related to the environment include dynamic changes, for example, seasonal changes or differences between daylight and darkness. In design processes, there are additional criteria beyond the micro-level [9] and a human-centered focus on P-E relationships as well as potentially conflicting interests to consider. Such criteria, not included in this paper, concern, for example, criteria from the producer perspective (e.g. marketability, profitability, materials, transportation, manufacturing, skills, work environment for production staff, ecological and economic sustainability) and the organizational perspective (e.g. embodying the visions of an organization, strategic objectives, branding).

2.1. Competence-press model

Lawton and Nahemow's [7] competence-press model concerns the relationship between the individual's internal abilities and the external demands of the environment. In the development of the competence-press model, the ageing processes of individuals and environments as well as continuous and mutual adaptations were central. Changes in the individual's competence need to be balanced with changes in the environmental press to achieve balance. Alternatively, the individual has to adapt to external demands by strengthening internal abilities. If the external demands exceed internal abilities, the outcome of the interaction is dysfunctional.

2.2. Framework of product experience

Desmet and Hekkert's [8] theoretical framework of product experience concerns all affective responses in interactions between individuals and environments. The framework indicates that there are patterns, both in the three different levels of experiences and in their own lawful underlying processes. Affective experiences can be positive, neutral, or negative such as pleasantness or unpleasantness, goodness or badness. The possibility to use the framework to describe the multi-layered and individual nature of product experience is one of its advantages.

3. Findings

The suggested compilation of P-E relationship concepts includes the three interaction types - instrumental, non-instrumental, and non-physical interaction - and five constituent concepts, i.e. accessibility, usability, aesthetic experience, the experience of meaning, and emotional experience (Table 1).

3.1. Instrumental interaction

Instrumental interaction refers to the everyday practical conditions of accessing, using, operating, and managing environments to serve particular purposes and achieve specific goals [8]. Concepts such as safety, evacuation (in the event of an emergency), or allergen exposure could be added next to accessibility in the suggested compilation of P-E relationship concepts with both factors related to the individual and the environment relevant for those concepts.

Accessibility as defined by Iwarsson and Ståhl [10] refers to the relationship between the functional capacity of the individual and the barriers to physical access to the physical environment (Table 1). The individual factors relevant to this definition are mobility, sensory, cognitive, and strength-related limitations. The factors related to the environment, that is the barriers in the material world, are based on official norms and standards. To use and benefit from this definition's possibility to describe the largely objective, observable and measurable nature of accessibility is one of its major advantages. However, the environmental factors are not constant as a phenomenon because there are international differences, and societal objectives changing over time. Accessibility as defined by Iwarsson and Ståhl [10] and also interpreted by the building sector and people in general, relates to individuals with disabilities and minimum compliance with norms and standards, rather than being a human right dimension [11]. This definition indicates that the P-E relationship concept of accessibility is necessary when addressing people experiencing one or more temporary or permanent disabilities during their lifespan. In addition, accessibility can enable or restrict participation in other situations such as when individuals bring a stroller, a suitcase, or being pregnant or with a friend facing accessibility issues. However, human differences exist beyond functional capacity.

Table 1. The suggested compilation of P-E relationship concepts for an understanding of universal design*ing*.

P-E relationship concept	Inter-action type	Involves	Individual factors[1]	Factors related to the environment[2]
			Mutual influence and control	
Accessibility (Iwarsson & Ståhl, 2003)	Instrumental (e.g. accessing, understanding, using, operating, managing)	Access attainment with a focus on functional needs and behavior.	Functional capacity Mobility, as well as sensory, cognitive, and strength-related disabilities.	Barriers to access in the physical environment. Based on official norms and standards.
Usability European Committee for Standardization (CEN) (EN 17161:2019)		The extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use. Task, use, operating, managing, maintaining, and goal attainments.	In addition Personality, personal history, age, life stage, gender, motives, attitude, skill, cultural identity, preference, hopes, aspirations, dreams, circumstances, role in a situation at any given time, and role in a group.	In addition Environment type, properties, characteristics, geography, architecture, scale, technology, social environment, culture, economy, politics, and use context.
Three levels of experience (Desmet & Hekkert, 2007)	Aesthetic experience / Non-instrumental	Perception with all the senses (e.g. beautiful, pleasant sound, good to touch, soft texture, nice smell, thermal comfort, discomfort, and wellness).	Senses Sensory modalities.	Perceived values The material presence of the environment and context of experience. Such as shape, texture, and colour.
	Experience of meaning / Non-physical	The meaning a person attaches to the environment (e.g. independence, sense of control, sense of belonging, attachment, and empowerment).	Cognition Cognition such as interpretation, memory retrieval, and associations.	Affective values The personal or symbolic significance of the environment.
	Emotional experience	Feeling and emotions (e.g. frustration, self-determination, dignity, pride, stigmatization, freedom, comfort, happiness, and atmosphere).	Cognition Affective phenomena, often automatic and unconscious, position vis-à-vis the environment.	Affective values The personal significance of the push and pull related factors of the environment.

[1]Individuals include those who access, use, and experience the output of the environment, those who operate the environment, and those who support the environment.

[2]Environments include goods, objects, products, systems, services, programs, packaging, user documentation, online and human help, support and training, etc.

Usability, which implicitly requires accessibility as a prerequisite, is defined as the extent an environment can be used *"…by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use"* [12] (Table 1). Thus, usability involves the performance of desirable activities, the specified individual's perception of goal attainment, and is dependent on culture, context, and social norms of use around an environment. Understanding and addressing usability requires more than focusing on functional needs and behavior. The fact that individual factors represent a substantial source of variation such as hopes, aspirations, and dreams [4] means that many individual factors in addition to functional capacity must be incorporated into usability analyses. Factors related to the environment include environment type, properties, characteristics, architecture, scale, technical, social environment, culture, economy, politics, and use context [13]. Usability focuses on functioning, activity, behavior, and cognition. A more holistic and human-centered approach also needs to take experiences into account.

3.2. Non-instrumental interaction

Non-instrumental interaction refers to caressing, playing, or interacting with an environment for delight, stimulation, and inspiration [8]. It is an interaction that has a value in itself, not just as a means to achieve a practical goal or purpose.

Aesthetic experiences concern the environment's capacity to delight one or more of our sensory modalities [8] (Table 1). In other words, the degree to which our sight, hearing, smell, touch, balance, and kinaesthetic are gratified or displeased. For example, green spaces and waterways can delight our senses and hence provide a positive distraction, promote mental and physical health, stimulate social cohesion, and support physical activity [14]. Generally, sensuous shapes (e.g. handrails), harmonic sounds (e.g. indication of the floor level and direction of lift travel), orderly organized elements (e.g. buttons on a lift control panel) soft texture (e.g. seats) are perceived as delighting. While noisy, dilapidated, or ugly disturbing and sudden sounds generally are perceived as distressing. In many contexts, moderate levels of stimulation are recommended because too much stimulation and complexity may cause unintended distraction and overload for cognitive processes and lack of stimulation may cause boredom or sensory deprivation [15]. Light levels and light directions can influence social interaction, particularly in communication with people with cognitive disabilities [16]. The concepts of thermal comfort and discomfort are here classified as aesthetic experiences because they relate to perceived sensory values such as cold, heat, biomechanics, restlessness, and fatigue [17]. Multi-sensory aesthetics should be preferred because diversity in needs demands many potential options and design solutions.

3.3. Non-physical interaction

Non-physical interaction refers to imagining, anticipating, or remembering usage [8].

Experience of meaning refers to the meaning individuals attach to environments (Table 1). At the level of experience of meaning, cognition plays a major role [8]. Interpretation, associations, and memory retrieval are examples of cognitive processes enabling recognition of metaphors, assessment of symbolic significance, and assignment of personality or other characteristics. Individual and cultural differences certainly

influence the cognitive processes involved. Factors related to the individual, environment, and the context influence experience of meaning. The experience of attachment represents profound and sustained meaning with feelings of confidence, independence, security, and control. Using a walking device can evoke other people's stereotypical beliefs, which in turn can generate affective reactions.

Emotional experience refers to the emotions and feelings that environments elicit (Table 1). Desmet and Hekkert [8] refer to affective phenomena such as desire and fear, love and disgust, pride and despair. Emotions are functional, because pleasant emotions will pull individuals towards certain environments interpreted as beneficial, and unpleasant emotions will push individuals away from environments interpreted as harmful. Importantly, it is each individual's interpretation or the significance he/she attributes to the environment, rather than the environment itself that elicits the emotion. The individual's state of mind influences the emotional response. Emotions are often a result of an automatic and unconscious cognitive process. For example, for individuals without hearing disabilities or headphones, a response to a fire alarm will most likely be the basic emotion of fear. However, the principle also applies to subtle emotions experienced in interactions between individuals and environments such as comfort-related emotions of plushness and well-being [17].

3.4. Comparisons and relations between the interaction types and the constituent concepts

The common denominator of the five constitution concepts is that they all describe the dynamic relationships between the individual and the environment – a mutually constructed mediation co-shaping subjectivity and objectivity. All the P-E relationship concepts must be analyzed by integrating both the factors related to the individual and the environment. With such an approach, the focus is on the role environments play in people's everyday life, which raises the need for a holistic view and a life course perspective, instead of a narrow focus on the properties that environments can possess (e.g. barriers; functionality; originality) or properties of the individual (e.g. disability; asthmatic condition). In all the five constitution concepts, the diversity of user needs and many potential options should be taken into account. Such an approach often improves the overall interactions between individuals and environments.

Moreover, the five P-E relationship concepts cover different aspects that all are important and complement each other. It is important to recognize their interdependence and impact on each other. Accessibility primarily concerns people with disabilities, while usability, aesthetic experience, the experience of meaning, and emotional experiences include everyone. In other words, the difference between accessibility and the other P-E relationship concepts is that accessibility has a focus on age or ability while usability and the three levels of experiences can include other instances of exclusion such as gender, socioeconomic, geography, race, religion, or belief. A difference between the instrumental concepts and the non-instrumental and non-physical is that the three levels of experience occur before, during, and after factual human-environment interaction while usability and accessibility occur during factual interaction. Therefore, accessibility is a prerequisite for usability – first access, second understanding, and third use [12]. Access is not necessarily required for the three levels of experiences that can occur pre or post-use without factual physical, and/or instrumental interaction. However, particular experiences can activate other levels of experiences and influence usability. That is,

environments perceived as aesthetically gratifying allow individuals to perform in the best possible way and achieve their goals, or the other way around, usage enabling individuals to achieve their goal may lead to affective responses. This explains, according to Desmet and Hekkert [8] why the three levels of experiences and usability have strong correlations. Based on a literature review of links between aesthetic experiences, emotions, motor inhibition, and learning, Sarasso et al. [18] suggest that aesthetics should not be reduced to merely decorative aspects but should instead be taken into account as a key part of how environments can influence learning and adaptation processes. Desmet and Hekkert [8] argue that experience of meaning and aesthetic experience can elicit emotional experiences. Likewise, environments that in various degrees are accessible and usable, having beneficial or harmful consequences for the individual, may elicit the experience of meaning and emotional experiences. Environments that provide access and allow individuals to achieve their goals will more likely lead to positive emotions [19].

4. Discussion

The suggested compilation of P-E relationship concepts embraces a wide variety of human and environmental contexts of interactions. All of the five constituent P-E relational concepts described are closely related to UD. A P-E relationship approach to universal design*ing* has the potential to illuminate complexity, raise awareness, encourage cultural shifts and make the UD objectives an integrated part of design research, education and practice. To better understand the complexities of UD and to reach cross-boundary consciousness, this paper suggests combining concepts of P-E relationships as criteria to support the operationalization of universal design*ing*.

The definition of accessibility suggested by Iwarsson and Ståhl [10] is often criticized for being too instrumental in the context of design. That may be true, but there are other P-E relationship criteria to apply when the focus for example is on instances of inclusion beyond functional capacity. An advantage of Iwarsson and Ståhl's [10] definition is that it makes the accessibility criteria concrete and objective. The Housing Enabler instrument [20], is a research-based instrument for assessments and analysis of housing accessibility problems based on the Enabler tool [21], developed inter alia for designers to incorporate body-environment relations into their analyses. A unique value of the Housing Enabler is that it takes the individual's, or group of individuals' functional capacity into account, juxtaposing it against the barriers in the physical environment. Thus, enabling the calculation of the degree of objective housing accessibility problems, classifications, and certifications of housing accessibility to create bridges between housing supply planning, physical planning, healthcare, and the public. However, the prevailing understanding that accessibility is about minimum compliance with norms and standards, constitutes an obstacle for such a P-E relationship approach to have an impact. However, the accessibility criterion is not enough to accommodate the widest variety and number of people. Usability and the three levels of experiences must be taken into account to address several instances of inclusion such as gender, socioeconomic, geography, race, religion, or belief. A broadening of P-E relationship concepts adds greater depth to the understanding of the interaction between humans and environments and creates conditions for the design of health preventive environments. In line with Ryhl et al. [5], emotional aspects must be equally incorporated to ensure that all users to the greatest extent possible are included.

UD is a means of considering all the P-E relationship criteria and human differences. To prevent overlooking genuine and diverse need, human-centeredness and the involvement of individuals at every stage in the design process is at the core of UD [4]. There is a need to develop theoretical awareness and conceptual clarity regarding P-E relationship criteria and consider them in universal design*ing* to support the operationalization of UD. The suggested compilation of P-E relationships can be of value for all individuals involved in design processes because it can facilitate their structured and creative attempts to design for inclusion, independence, dignity, and social participation.

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