Inaccessible Augmentations: Ambient Displays’ Two Sides of Space

Abstract
An analytical study for designing space with embedded ambient displays as a dual system that shares physical and hybrid characteristics requires an intersection of Architecture and Human-Computer Interaction. In this paper we propose to examine the application of research methods for understanding the impact of ambient displays in architectural design through Space Syntax theories, which confines a set of theories and techniques for analyzing space.

Here we present an early approach for developing a theoretical framework for understanding the complex relations between ambient displays, physical space and humans; and the impact of augmented projections on people’s navigation in space and to a greater extend the socio-economic implications.

Author Keywords
Ambient display; architecture; movement; space syntax; hybrid space.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.
**Introduction**

The introduction of digital technologies in architecture has allowed the formation of new relations between space and people redefining the spatial properties of the environment. Embedding ambient displays in design requires a new way of thinking of how these systems interweave with architectural space and people’s perception. Ambient displays can simply augment walls creating more pleasant environments [1, 2] without changing the physical morphology of space. Such augmentations allow space to be transformed into a dynamic environment in which boundaries are dissolved. Our interest lies in extending and adapting our understanding of architectural design by looking at space as a dual system of physical and virtual properties incorporating human’s behavioral and perceptual changes.

**Two Sides of Space**

It is generally accepted in architecture that the structure and configuration of space affect people’s navigation and movement. Gibson’s research, which was primarily developed for visual perception, suggests that our senses provide us with direct awareness of the external world and its properties [3]. People perceive space with their senses and act accordingly, thus there is a tight relation between perception and movement. ‘Space Syntax’ research shows that the majority of human movement occurs along the longest lines of sight, and that the more open visible space we have in front of us the more we tend to move towards that direction [4]. The emerged movement patterns not only influence the dynamics of the built environment but also shape social behaviors and co-presence in space [4, 5].

**Figure 1.** Ambient display as digital transparency.

The placement of an ambient display in physical space introduces a transparent layer of a dislocated virtual depth. This interface can be considered as a digital opening in a form of a virtual window that extends both architectural space and the vision of users in a given space. Like a window that connects two physical spaces transferring information between them, an ambient display can be seen as a link between physical and virtual worlds.

Drawing on this approach, we suggest that the factors that determine the impact of ambient displays on people’s behavior are (i) the content of the display and (ii) the relation between the physical and projected virtual spaces.

When mentioning the content of the interface, we refer to the visual depth of the ambient projection. As revealed from previous research [6] an ambient display
that shows typical two-dimensional information has no change on pedestrian route choice behavior. When the display shows a projection of another space, the presence of the augmented visual depth influences route choice behavior.

The second factor highlights the importance of the projected vanishing point. A non-centered perspective projection of a space influences route choice behavior towards the side of the projected vanishing point [7]. Moreover, a skewed projection changes the geometric representation of space and lengthens the line of sight towards the side of the vanishing point. Therefore, a subliminal direction is imposed towards this augmented longest line of sight.

**Figure 2.** Example of ambient display with skewed projection.

The introduction of new transparencies through the use of ambient displays extends physical space into virtual world creating a dual system with new spatial configurations that challenges human’s perception of space. The emerged spatial configurations include properties and relations of the physical space and also all those relations rising from the presence of the virtual projections. Based on Space Syntax, spatial layouts affect functioning [8,9]. It is also suggested that movement patterns influence the co-presence in space and thus the social interaction. We believe that this impact will be more intense in hybrid environments where the augmented virtual depth makes the visibility and angular relations fluid. Indeed, the introduction of ambient displays in space can engage people to adhere to certain kinds of desired movement patterns [6, 7].

**Figure 3.** Augmented visibility diagram.

We have so far argued that an ambient display can affect the following:

(i) Spatial configuration
(ii) Movement patterns
(iii) Social interaction / co-presence
As previous research reveals [10,11], each of the above factors plays a critical role in determining the socio-economic life. Therefore, any occurring change that reforms the existing relations among them can have a certain number of ramifications. We suggest that the placement of ambient displays can contribute in the formation of desired socio-economic relations within space.

Conclusion
We argue that embedded ambient displays influence people’s perception of space and alter the existing spatial configuration. Moreover, an ambient display that extends the visual depth into space can engage people to follow certain kinds of desired movement patterns. This change can be strengthened further when repositioning the projected vanishing point. Drawing on these observations and the consideration of different levels of social interaction that occur in environments with ambient displays, we propose that the presence of ambient displays in physical space can influence the existing socio-economic factors. We understand that further analysis and experimentation is needed in order to analyze the impact of ambient displays and design a complete framework that addresses all the factors discussed above.

References