

Material meets the City: New Trends in Urban Interaction Design (UIxD)

Key Insights:

1. Natural, augmented materials enable calm, peripheral interaction that foster an increased socio-spatial awareness.
2. Asynchronous places communication increases the individual's spatial awareness.
3. The material choice and properties in UIxD are essential to arrive at a holistically sustainable design.

Our urban built environment is shaped by many aspects, such as transportation, human activity, and materiality. Materials, their affordances, and experiences play a particular role in this context, influencing what we perceive and how we interact. In the past decades, the main developments in Urban Interaction Design (UIxD) looked at media facades as public displays or the augmentation of smart buildings toward more sustainable energy consumption. These applications, though, have little connection to daily public activities and their social dynamics. In comparison, the urban outdoors is still quite dominated by physical artifacts and their material qualities with limited embedded digital technologies. Questions arise, such as, what influence material qualities and choices have on urban space design? And what trends derive from this influence that are relevant for interaction design?

In UIxD, design trends deal with community engagement, psychological and physical well-being, and sustainable ecosystems. For each of these topics, interfaces are meant to support, connect or enable, requiring them to be relatively calm, peripheral, adapted, and embedded into the context. These requirements limit the material choices but also challenge designers to rethink and re-explore all kinds of materials. In a half-day studio at TEI2021 [Hirsch2021], we explored a range of traditional, natural, and artificial materials and their potentials with eleven participants from diverse backgrounds, ranging from architecture to interaction design and psychology. Participants were requested to contribute a picture selection of three materials and three public urban places of their choice and introduce them during the studio. This introduction formed the discussion basis for the two consecutive brainstorm activities. In the first brainstorming, the groups developed novel spatial interaction concepts at urban locations of their choice. In the second, they selected a set of materials to implement their ideas and ways their material choices would influence the experience. Here, we present our main findings and reflections on the material themes and outcomes of the brainstorming activities.

The Role of Material Choices

When describing material qualities and affordances, one soon realizes that descriptive words, such as durable, rough, soft, or fragile, lead to semantic ambiguity and do not fully or precisely encapsulate said qualities and parameters. Beside describing perceived qualities at a specific point in time, materials age as a reaction to external forces and usage. They start telling a story of their own, shaping our interactions and experiences [Giaccardi2015]. Reflecting on our studio outcomes, we took note of prevalent material themes, which we clustered in categories: ephemeral, reversible and resilient, seasonal, traditional, and advanced.

Ephemeral, Reversible, and Resilient Materials

Under this theme, we identified material qualities regarding a material's state, whether permanent, temporary, or insignificant. Some of the materials presented by the studio

organizers were materials used in Ephemeral UIs [Döring2013]. The term refers to materials with intrinsic limited lifespan properties that are directly applied to the interaction, such as snow, soap bubbles, or fog. Participants brought forth other materials that incorporate the ephemeral aspect, such as fluorescent, thermo-, or hydrochromic ink or shape-memory materials. These materials, however, are perceived as reversible as their state change is non-permanent. For example, thermochromic ink reacts to touch by color-change due to the temperature difference. The change fades with leveled temperature, reversing to the original state. In comparison, resilient materials resist change persistently and irrevocably over time, whereas their weathering adds to the aesthetic experience of their original shape and affordance. A popular resilient material example is wood, one of the most used construction materials due to its versatility and durability.

Seasonal Materials

Materials perceived as natural or organic, such as vegetation, leaves, and green walls, monopolized the interest of the studio participants. This trend aligns with the growing interest of HCI research in plant-computer interaction, where plants can be employed as both input and output devices, interfaces of nurture, and as inspiration for biomimetic systems [Aspling16]. A variation of these natural materials that change state seasonally could be elements such as snow or sand. Two of our participants' selected photographs that depicted footmarks, animal traces, or other remnants of activity imprinted on earth or snow and "erased" by weather changes. This quality could potentially foster asynchronous or temporary interactions by leaving messages on or with the use of seasonal materials.

Traditional vs. Advanced, Hybrid Materials

Among the participants' material selection, some traditional materials were also prevalent, such as metal, roof tiles, and stone, materials already dominating the urban built environment. The relatively recent material turn in the HCI realm urges us to think of computation embedded into existing physical materials, resulting in hybrids, novel, and advanced materials. With the revolution of DIY materials and collaboration with material scientists and engineers, traditional, prosaic materials are reimagined and enhanced with computational capabilities. One such example is capacitive concrete [Hirsch2021], a new form of interactivity whose shape is redesigned to invite interaction in various urban environments. Advanced, hybrid materials open up exciting possibilities for truly embedded UIxD interfaces for peripheral or calm interactions. The domain they are situated in allows for citizen engagement and participation on a larger scale.

Spatial Interaction Concepts: Fostering Awareness in UIxD

One of the main discussed concepts in the studio was the environments' potential to communicate how and by whom or what it was used. Considering the material qualities mentioned above, environments could make transparent how others used the space, what activities were conducted or how humans and other types of life moved through it. By revealing traces of the ecosystem, the environment fosters socio-spatial awareness beyond the human perspective. Material traces or patinas of use indicate behavioral patterns, such as cutting corners by creating a footpath through a green area or the worn-off colors and smooth surfaces of a bench where people preferred to sit. The same applies to animal traces, such as gnawed-off wood or prints on the ground. Particularly the latter represents ephemeral traces that quickly disappear or dissolve depending on the material basis.

In comparison to indoor applications, outdoor contexts are also highly influenced by seasons, be it the rain season in one part of the world or the snowy winter season in another. Accordingly, activities and their traces change over time and are constantly impacted by other external forces, such as weather elements. On the one hand, these dynamic changes represent a challenge for urban interaction design. On the other hand, it offers opportunities for a new design direction of seasonal interfaces.

Fostering awareness for places' vividness enables individuals to understand the overall atmosphere of a place, which, in turn, promotes a more intense in-the-moment experience enriching people's well-being [Weijs-Perrée2020]. We see the potential in combining an environment-centered design approach with a user-centered design approach to create more engaging urban places. This includes following up on questions, such as to which extent we should consider and reveal the surrounding ecosystem in UIxD and what is natural and sustainable not only for individual users but also for the fauna and flora of the environment. When it comes to the outdoors, there is a co-dependency of taking advantage of a more transparent, communicating environment and the designers' increased responsibility of holistically accommodating an ecosystem.

In our studio, participants emphasized the relevance of nature's recreational, calm effect that should be maintained and supported. We mentioned park areas, community gardens, and urban water bodies as more natural locations in the urban realm. These shared public places already allow an increased spatial awareness and a more mindful interaction with oneself and the environment. In the example of the community garden, they may also foster a sense of community through shared activities with a common goal. A place's affordance of activities also contributes to being present and increases the awareness of one's surroundings. Accordingly, the type of activities offered at a place contributes essentially to its meaning, perception, and level of interaction. Relating it to material choices and material traces, we see a bi-directional effect as presented in [Giaccardi2015] of activities shaping materials and materials shaping activities. We see an additional component influencing the relationship - the places themselves.

Relating Materials and Places

Place-making describes the process of turning a meaningless space into a meaningful place. The process is highly influenced by the place's affordances and activity potential. In turn, these depend on the material choices and properties and how artifacts are positioned to each other in space. Combinations of material types allow for different activities and aesthetics. They influence a place's atmosphere, which contributes to its overall meaning and understanding. People build relationships with places based on the experiences they have.

Material-Place Relationship Example: Urban Water Bodies

Water can take any shape and size. Its embodiment defines whether the current runs fast, slow, or stands still. Taking a fountain as an example, its basin is often built at a comfortable height to sit and relax. It invites us to certain activities, also because of how it is spatially positioned to the ground and other artifacts. In comparison, a change in the water's state of matter can turn a canal into a hockey playground or ice-skating rink in the winter season. It shows the effect that material properties can have on their embodiment and socio-spatial experiences.

Place-Material Relationship Example: Public Gardens

The spatial plant arrangement in public gardens essentially influences how individual plants grow, shape and bloom. Some plants, for example, compete with one another or share nutrition, sunlight, etc. Accordingly, the spatial conditions of the place can either foster the longevity of vegetation or reduce it. It is a similar effect on other materials and their traces of use. The place's affordances can guide people toward certain artifacts or locations, which, at the same time, would increase their usage and fasten their aging process. In comparison, other materials might stay unnoticed, and hence, untouched for a long-time. Imagine a shovel stored close to the flower bed compared to a shovel that might be stored further away. The closer one is more comfortable to reach and, thus, might be used more often.

Places and their spatial arrangements influence the material experience and vice versa. This introduces new design possibilities and trends to UIxD.

Meaning for Future Developments and Trends

UIxD has been shifting away, for some time, from media facades, urban screens, and projection displays, to an embodied view of humans and other living beings in urban environments. We think that exploring the relationship between place and material can add meaningful perspectives to current developments in UIxD that point to situated interactions, multi-sensory experience, privacy, playfulness, and ecological perspectives.

One conundrum of UIxD is balancing visibility with unobtrusiveness. The intrinsic relationship between material and place can help achieve the vision of blended interaction due to the countless possibilities materials open for any specific context. Fluorescent or hydrochromic ink, which was mentioned above, can be integrated within environments seamlessly while remaining visible to users. The material-place dyad can also drive new design approaches on multi-sensory experiences by using material properties, texture, and potential haptic interactions.

Data privacy is becoming central to the design of urban interactions. A material-place perspective can be an alternative to the challenges of location-based applications. Embedded systems can collect anonymous data on uses and traces in certain public places, rather than the demographic details of who those users are. This can ensure anonymity while also gathering relevant data about how a place is used.

The playful and social nature of urban life is the backbone of UIxD: urban experiences are often movement-based, fleeting, and spontaneous. How we nurture these important qualities of public space in the context of physical distancing, public anxiety, and safety will continue to be a critical issue for UIxD for the months and possibly years to come. Materials can provide forms of safe place-based interactions, engaging citizens through traces or ephemeral interfaces.

Finally, UIxD is becoming more concerned with the undeniable role of urbanization in ecosystems and the well-being of human and non-human life. That implies questioning the role of UIxD itself and the part it plays in the degrading of the environment, by generating waste through digital interfaces. What better way to set an example than by acknowledging the relationship between places and the natural materials that make them unique?

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