

Material Meets the City: Exploring Novel and Advanced Materials for the Smart Urban Built Environment

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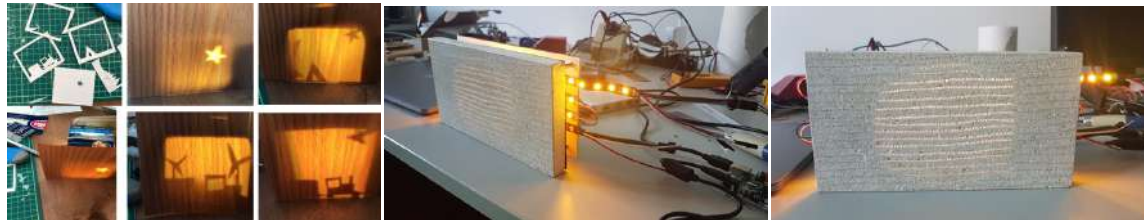


Fig. 1. Novel and urban material examples that will be presented at the studio. Left: Simple shadow theatre using paper cut-outs, translucent wood, and a light source, Center and Right: Translucent concrete.

The urban realm is currently undergoing a transformation in which cities are being laced with sensors and networks of ever-connected devices. At the same time, more and more novel and advanced materials are finding their way into interaction design and Human-Computer Interaction (HCI) research, offering us new interaction possibilities. In this half-day online studio, attendees will have the opportunity to exchange and reflect on urban interaction designs for user engagement based on a set of novel, unconventional, or omnipresent materials in urban environments. We will further collect historical, public, and community locations of different social and societal meaning. Participants will be asked to develop hands-on concepts and use cases for the selected locations through a material-centered approach and think about new levels of user-environment engagement to extend and explore the current design space. The formulated concepts and use cases will be recorded in an online collaboration tool with the prospect to publish them as enhances for the new generation of media architecture.

CCS Concepts: • **Human-centered computing** → **Ubiquitous and mobile computing systems and tools**; • **General and reference** → **Design**.

Additional Key Words and Phrases: Urban Environments, Material-Centred Design, Design research, Novel Material Applications

ACM Reference Format:

Linda Hirsch, Eleni Economidou, Irina Paraschivoiu, Tanja Döring, and Andreas Butz. 2021. Material Meets the City: Exploring Novel and Advanced Materials for the Smart Urban Built Environment. In *Fifteenth International Conference on Tangible, Embedded, and Embodied Interaction (TEI '21)*, February 14–17, 2021, Salzburg, Austria. ACM, New York, NY, USA, 7 pages. <https://doi.org/10.1145/3430524.3442701>

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Manuscript submitted to ACM

1 INTRODUCTION

The discussion on material qualities and material choices of urban interfaces is an ever-evolving one. Especially in media architecture, the challenge of integrating novel interfaces into the target environment as well as their effect on the existing social conditions and structures are main considerations in the design process [8]. Sustainable materials play a particular role in developing smart urban built environments [15]. Such materials introduce new possibilities of engagement that haven't been much explored in urban environments, especially from a user perspective.

In our studio, we want to explore the materials using a material-centered approach [20] (Figure 2) combined with brainstorming use case scenarios. As presented in Figure 1, we present two advanced main materials which are ubiquitous in urban contexts - concrete and timber. We look at altering existing urban and novel and unconventional materials and environments to enable users to interact with their surroundings directly. In turn, users can create meaningful experiences and relationships with their surroundings, strengthening their "identification with the city" [2, 41].

2 URBAN INTERFACES - CHALLENGES AND TRENDS

The emerging field of Human-Building Interaction focuses on the individual and shared user experiences with the built-environment [2]. Environments are hereby the socio-ecological contexts consistent of artifacts (including buildings) and spaces that receive their meaning through interaction with and activities within it [1]. Currently, pervasive displays [5] and media facades [8, 22] still belong to the main trends in urban interface design. However, the field has developed increasingly diverse, such as mobile [6, 24], smart [4, 29] or sustainable [3, 30] interfaces. One of the main challenges for pervasive displays is the so-called "display blindness" [9, 19, 28]. It implies that passers-by either deliberately ignore the interfaces as they don't expect any interesting content [28] or that their attention is already engaged elsewhere [9]. In comparison, media facades cause environmental issues such as light pollution [15, 42] or lack a "meaningful integration" with the built environment [25]. Houben et al. [25] speak thereby of creating places which react dynamically to passers-by input to create a collective, social atmosphere. Other research emphasizes the importance of the social value and community engagement of an urban interface [4, 23, 24] as well. In fact, a sustainable design involves sustaining human's psychological and physical well-being [3] along with sustaining a community's cultural heritage [36].

Sustainable urban interfaces offer a broad range of perspectives and functionalities that overlap smart or mobile interfaces. For example, Mohamed and Nabil et al. report on smart materials in the built environment, including sustainable, organic materials, such as smart bricks, self-healing concrete [29], or shape-changing, deformable materials [31] that enable a dynamic fusion of interfaces and the built environment. Instead, Morrison et al. [30] introduce a more user-centered perspective by contributing to calm, restorative user experiences. They connected a wearable to a vibro-acoustic wall to create a responsive urban environment.

In comparison, mobile interfaces are another interface design area which is mostly dominated by urban robotics. Drones [6] or free-moving, autonomous robots, such as Woodie [24] are example projects which aim at investigating the

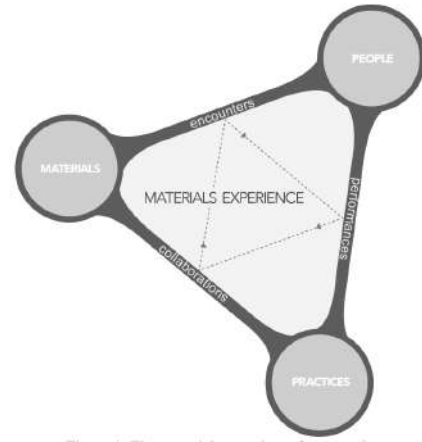


Fig. 2. The materials experience framework by Giacardi and Karana [20].

relationship between agents, users, and environments. Additionally, concerning agent interaction, research in urban interface design turns more and more toward the social integration and the societal changes caused by the increasing ubiquity of autonomous agents. It relates to the topic of *placemaking* [13, 14] and the role that our surroundings take in our lives. Overall, the urban interface design trends towards sustainable, smart, and social installations where the well-being, preservation, and longevity of humans, nature, and other living beings are one of the main priorities.

2.1 Exploring Novel Applications of Materials

During the past decade, the notion of materials and materiality has gained popularity in the TEI community. Crucial to building theory on tangibility, this *material turn* [34] requires us to think about computational materials as hybrids [16] of the physical and the digital. Emergent material-focused research methods escape the narrow focus around computational possibilities as they are directed on imagining and designing interaction via material manifestations [40]. In contrast, conventional, prosaic material can be re-imagined as a novel once again when paired with computation. Alternatively, novel, unusual and advanced materials unveil new unprecedented form factors and interaction possibilities. Progress in material science and material-related engineering and the personal manufacturing revolution led to an increase of methods on designing and fabricating with novel materials [21, 32, 33, 39].

Computational properties can only be explored to their full extent when combining the computer with other material [12, p. 71]. What is meant by the term material though? *Material* can be interpreted in various ways that go beyond the “*physical substance*” [38] depending on the context and the point of view. Fuchsberger et al. describe material as something that emerges through design or use [18] where interaction materials can be *intangible* (e.g., air, light or steam) [27], *computational or digital*, (i.e., bits and bytes) [27], *ephemeral* [10], *computational composites* [37], or *hybrids* of the physical and the digital [7, 16].

This material turn or redefinition in HCI research led to approaches that place the material first. In our studio, we will use the analytical framework on materials experiences [20] by Giaccardi and Karana that looks at material experiences on four levels (i.e., sensorial, interpretive, affective, and performative). The *inspirational bits* by Sundström et al. [35], an approach that also looks at material experiences is rather directed at computational materials and their experience properties. In contrast, other approaches take into account the user as well. For example, the materiality-centered approach by Fuchsberger et al. couples a human-oriented perspective and an artifact-oriented perspective [17], whereas the *material probe* [26] method by Jung and Stolterman looks at users’ mental connection when it comes to physical material.

3 STUDIO PROPOSAL

Our virtual studio will allow participants to exchange and reflect on materiality in urban contexts. In the first part of the studio, we will collect, discuss, and brainstorm a set of novel, unconventional and urban materials concerning urban locations provided by participants. Participants are therefore asked to provide pictures of public, historical, or community spaces from their vicinity (e.g., Figure 3) and pictures of different materials before the studio. In the second part, we will focus on in-depth discussion in smaller groups of individual cases. We will encourage participants to use their place-based observations for imagining concepts and use cases to enhance the lived urban experience.

We will provide participants with visual sample kits and other supporting materials to brainstorm and sketch their imagined uses. The brainstorming will be guided by the four levels of the analytical framework on material experiences [20]; sensorial, interpretive, affective, and performative. The goal is to identify opportunity spaces, open questions, and potential challenges of integrating different materials and materiality in urban contexts.



Fig. 3. Three vibrant urban location examples. Left: A public square in Lehen, Salzburg - an area with galleries, schools and residential buildings functioning as cultural melting pot. Center: One of the most popular places to visit in the historical center of the city, Residenzplatz - a large, stately square. Right: The public square in front of the central train station, a transportation hub, serving multitudes of visitors and travellers every day.

4 STUDIO LEARNING GOALS AND DISCUSSION OBJECTIVES

Participants will gain deepened knowledge about the design space for the collected materials and locations introduced in the studio. Discussing them will enable participants to reflect on different levels of experiencing materials and envisioning their application in different urban contexts. In particular, we will discuss the applicability of existing theoretical frameworks [11, 20], to specific contexts in the urban built environment. We will focus on use cases for the presented materials and locations, open questions, challenges, and speculations for interaction instances in the interactive urban built environment.

5 PROPOSED STUDIO SCHEDULE

Our prospective schedule might have to be adapted accordingly depending on the different time zones from where our participants will join.

2:00 – 2:15p.m.	Welcome and coffee
2:15 – 3:00p.m.	Introduction of participants, organizers and the studio topic
3:00 – 3:30p.m.	Brainstorming of the potential connection of collected materials and the urban built environments
3:30 – 3:50p.m.	Break
3:50 – 4:30p.m.	In-depth discussion of selected use cases in smaller groups
4:30 – 4:45p.m.	Preparation of group presentations
4:45 – 5:05p.m.	Break
5:05 – 5:45p.m.	Presentation and discussion of results
5:45 – 6:00p.m.	Wrap-up and next step

6 EXPECTED OUTCOMES

Participants will conceptualize different use cases for the gathered materials. Based on their brainstorming, we will build the foundation to design future prototypes for defined urban contexts from a material-centered perspective. We hope participants will take up these results in their future work and continue their explorations. On the studio website, we will host an open-access "Navigator" containing studio outputs in a visual form: materials, contexts, frameworks,

open questions, challenges. We plan one or two future publications deriving from the studio, such as a joint effort TEI 2022 paper to which we invite all studio participants to collaborate.

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