# The Impact of Hyperconnectedness on Urban HCI: Challenges and Opportunities

Callum Parker
The University of Sydney
Sydney, Australia
callum.parker@sydney.edu.au

Glenda Amayo Caldwell
Queensland University of Technology
Brisbane, Australia
g.caldwell@qut.edu.au

Joel Fredericks
The University of Sydney
Sydney, Australia
joel.fredericks@sydney.edu.au

## ABSTRACT

As digital technology adoption is rapidly increasing, so too are digitally augmented public spaces which are supported by a mass of underlying invisible technologies. While the visible public technologies within them commonly consist of public interactive displays and media façades, personal technologies, such as smartphones and wearables, have also proliferated. The rise of personal technology usage in particular has caused society to shift towards a new paradigm of hyperconnectedness, where people are constantly connected to the internet through their personal devices. Considering this, the role of digital urban interventions (DUI) and their relevance to citizens in hyperconnected societies has become questionable. In this paper, we reflect on traditional forms of DUIs and discuss how they fit into a hyperconnected society, exploring challenges and opportunities. The primary aim of this work is to contribute a roadmap for urban HCI, highlighting the key topics that should see more focus moving forward.

## CCS CONCEPTS

• **Human-centered computing → Human computer interaction (HCI)**.

## KEYWORDS

Hyperconnected Society, Digital Urban Interventions, Urban HCI, Design

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## 1 INTRODUCTION

Around the world, cities and the public spaces within them are changing due to advances in digital technologies and society's increasing dependence on them. This has led to the notion of "*smart cities*", that is, cities with embedded digital technologies for the purpose of improving the lives of urban dwellers within them [39]. Smart cities are commonly enabled through sensors to implicitly automate manual processes, such as turning on lights or walking up stairs. However, cities were not necessarily built from the ground up to be smart, rather they are gradually becoming smarter over time as technology becomes more extensible and embedded within them [11].

These technological advances are leading society towards hyperconnectedness, changing the way citizens engage with urban environments and providing ubiquitous access to information on the internet anywhere at any time through smartphones [6, 34, 42]. This has led to urban environments that cater for personal device usage through quick response (QR) codes and near field communication (NFC) [2, 3, 28], giving objects that exist in urban environments a form of meta information that can be accessed through a smartphone. Furthermore, public space is starting to accommodate personal device usage through supportive infrastructure, such as charging stations which enable citizens to charge their smartphone's battery.

Along with personal technologies, public space also includes a number of public technologies like public displays, which are commonly used for advertising [1, 32]. However, a growing amount of work has been investigating the viability of urban technologies for engaging communities on local issues that matter to them and provide urban dwellers within these communities a public platform they can use to voice their opinions on community matters [12, 22, 36, 38, 45]. In this work, we refer to these as digital urban interventions (DUI) which contribute to the '*smart*' of smart cities by engaging urban dwellers with situated community centred content.

While DUIs have been successfully used for community engagement [4, 18, 22, 33, 36, 45], the purpose of such technologies in a hyperconnected society is questionable. In response to this, we explore this topic and discuss what it means for Urban HCI, identifying three factors (Hybrid interactions, Engagement, and Location). We then contrast and reflect on these factors in relation to our own DUI deployments. From this, we identify key areas that need further exploration, laying out a roadmap for future urban HCI research.

## 2 BACKGROUND

Cities, regional centres and rural locations throughout the world are increasingly adopting smart technologies to boost information and communication capabilities, streamline public services, improve regional and global competitiveness, enhance transport networks, and augment social capital for greater social, economic and environmental outcomes [16]. Of particular interest to our research is how access and use of smart technology affects the experience of people within urban environments through hyperconnectedness. Urban HCI is a broad term that has been used to describe situated


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architectural effects, an interface, and associated computer system interactions within the city context [13]. These interactions include public displays, media façades, situated popups, and augmented reality (AR). In this section, we discuss some of the challenges facing Urban HCI. However, these challenges are not new and have been a part of an ongoing discourse around situated urban interventions within public spaces [17]. Mitchell [27] foresaw buildings turning into large scale computer screens and digital façades. Films such as Ridley Scott's (1982) Blade Runner[1] depicted future cities that were set in 2019 with entire buildings covered in digital screens promoting advertisements. Townsend [41] predicted that this surge of access to communication tools and connection to information would decentralise decision making processes while increasing the efficiency of urban systems [41]. He predicted screens of all sizes are cluttering not only urban environments but nearly all aspects of daily life. Fredericks [16] classifies this as "*digital urban spamming*", which causes a disconnection between people and technologies located within urban environments. As a result there are continued explorations as to what these technologies can offer people and the cities they live in.

Industries, business entities, and governments have welcomed the real-time and smart city visions with open arms as they are anticipated to help make cities more efficient through big data [23]. However, smart cities initiatives have predominately been criticised along three broad areas: (1) social sorting due to a mixture of location based services and digital signage [15]; (2) constant surveillance through data tracking devices and sensors [26]; and (3) due to mobile screens people disengage with public life and resort to their "*privatised tele-cocoons, bubbles or capsules*" [9]. Many scholars continue to question what this over reliance on technology really means to the individual; and in the case that things should fail, what does the future really look like?

From another perspective De Waal [10] examines the "*city as an interface*" where the city adapts and changes to suit the changing collective practice and values of social spatial protocols. The ways in which people relate to or interact with one another in public space is mediated through the different layers of physical and digital spaces. He uses the term urban media to broadly encompass the range of labels coming from different disciplines such as ubiquitous computing [43], locative media [40], ambient intelligence [8], internet of things [46], the sentient city [37] and urban informatics [14].

Similarly the discourse goes from the current views and the common misconception that technology usage through mobile phones, smart devices, and the creation of big data from sensors and collecting every move we take will create more efficient and liveable cities. While personal technologies have enabled augmented citizens through ubiquitous information access, they have also begun to entrap citizens within information bubbles [15]. This can have implications on our connection to public space and the way we use it, where users may only see certain events happening in the city related to their interests. This is not necessarily a negative aspect, but it does have the potential for changing the typical experience in public spaces, from public, shared experiences, to more individual, personal and possibly over curated experiences.

[1]Ridley Scott's Blade Runner film - https://www.imdb.com/title/tt0083658/

The underlying theme connecting the work of these different scholars is the focus back onto the individual and highlighting that the technology itself is not the answer. It is however, the way technology is harnessed, adapted and appropriated by different actors to make their experiences of the cities they live in the best possible. There are a number of questions that continue to arise: (1) how will architects, urban designers and urban planners continue to respond to this?; (2) How will they create public spaces that enable or mediate technologies, materials, spaces and places that continue to connect people with one another?; (3) How will this ultimately make cities more vibrant and liveable?; (4) How can architects collaborate with interaction designers, urban planners, and urban informatics to engage with concepts and design for spatial and citizen agency?; (5) How will they tackle environmental issues affecting cities like climate change?; and, (6) in the context of cities, what is the role of urban HCI?

These are challenges for urban HCI as a sub-species of HCI research to continue to develop. We propose that by including perspectives from urban and built environment academics, professionals, and practitioners there are many opportunities to continue to address limitations and harness the benefits of hyperconnectivity in the experience of urban environments.

We propose to further build on the previous research examples of Urban HCI discussed above in order to: gain a greater understanding around the design of DUIs within hyperconnected societies; ensure they are located in the right place and the right time; and, provide a variety of alternative ways to interact.

## 3 CONTRASTING RESEARCH CASES

Diving deeper into potential design approaches for DUIs in hyperconnected societies, we reflect on three of our DUIs used in past research studies. We have identified three key themes, which have emerged from the literature discussed above: (1) Hybrid interactions, (2) People, and (3) Location. These are contrasted with a discussion around the challenges that occurred during their deployment and the opportunities identified from participant feedback during their respective studies. Our intention is to further contribute towards the current dialogue within Urban HCI to identify the opportunities to better design DUIs in hyperconnected societies.

### 3.1 The InstaBooth.

The aim of the InstaBooth was to create a platform for communities to express their voice by sharing their thoughts and ideas in an unstructured and playful way. To achieve this the InstaBooth could be configured and adapted to suit different locations, contexts, and engagement strategies. Its modular structure provided the ability to interchange interaction modules or discrete elements that were designed to pose a question through digital, tangible or hybrid approaches. These included paper drawings hung on a clothes line, tablet interfaces with interactive maps or photo voting apps, or open ended questions physically posted on boards, as seen in Figure 1A.

**Hybrid interactions.** By incorporating robust and simple interactive technologies within the InstaBooth users were able to use their personal devices to communicate. They were also able to interact with screens and devices in a combination of familiar and novel ways. By leveraging people's interest in interactive technologies we


**Figure 1: The cases discussed in this paper: (A) The Instabooth; (B) Hive; and (C) Pop-spot.**

were able to attract users to the InstaBooth and obtain meaningful engagement from many of them. This provided a unique experience in seeing the ideas of others through either their tweeted message or hand written note. It was this combination of material, tangible and digital, that created a hybrid experience in urban environments that is different to experiences provided by personal devices.

**Engagement.** Depending on the context, partners, and engagement strategy the deployment of the InstaBooth would have a combination of researchers and partners present to varying degrees. In some instances the researchers were responsible mainly for installing and preparing the InstaBooth while the partners were present to engage with the public. In other instances the partners were not present and the researchers engaged with the public and would interview participants after they interacted with it. In most instances the researchers and partners would work together to engage with the public.

**Location.** The InstaBooth was deployed in a variety of public spaces including a village main street, public urban square, a festival, the foyer of a corporate building, a hospital waiting room, a busy train station, outside a city library, a museum, and a shopping centre. With each deployment the InstaBooth was an intervention in the space that had to respond to different contexts, interests, engagement strategies, stakeholders, and users.

## 3.2 Hive.

Hive featured a custom developed digital community noticeboard on a 50-inch widescreen public display. It contained content that featured local news, items for sale, and property rentals. Users could engage with the content directly on-screen or through a custom developed smartphone augmented reality (AR) app (Figure 1B). The app had two distinct features, overlay and remote control. The overlay allowed users to see personalised content overlaid on the display, based on a user profile containing user preferences stored in the app. The remote control feature enabled users to control the display by performing swipe gestures on the display through their smartphone's camera feed. The study with this DUI was held in a public space, nearby a University cafeteria and common area. We invited 10 participants to engage with the DUI and provide feedback on their experience. At the same time, we observed the participant, the space, and the behaviours of passers-by.

**Hybrid interactions.** This DUI allowed users to engage with a public display using smartphone AR. The non-traditional and unconventional interaction method revealed some interesting findings about how such a DUI stands out in public space.

**Engagement.** As the researcher was present during the study, passers-by would come and approach the researcher to find out more information about the DUI and how they can engage with it using their own devices.

**Location.** The DUI was situated in a large thoroughfare and was visible to people walking through the space, those lining up at the cafeteria, and people working in the common area.

## 3.3 Pop-spot.

In this work, we focused the engagement context around transport infrastructure to and from a University campus. This ensured that the engagement topic was relevant to the local community. It was further loosely linked to an initiative at the University concerned with active transport on campus. We consequently developed our engagement strategy to encourage people to stop and vote, provide feedback, and express their opinions about transport infrastructure on and around the campus. The booth (Figure 1C) was designed as a modular structure incorporating five transport themed engagement activities, consisting of digital, physical and mechanical input and output channels.

**Hybrid interactions.** The varied interactions helped when it came to engagement, as people had different options to engage with the booth depending on their preference. For instance, the chalkboard module provided a physical, analogue interaction by allowing participants to freely express themselves about public transport with both text and drawings. The other modules enabled people to express themselves digitally, through an iPad voting system, selfie booth, and a chalk drawing robot. The robot accepted input in the form of Twitter "*Tweets*".

**Engagement.** During the deployment, researchers were always present to assist people engaging with the DUI and interviewing them after they finished engaging. Some people also approached the researchers with questions about the booth and feedback regarding Sydney's transport.

**Location.** Pop-spot was situated outdoors within a University campus. The location was on the main path to a nearby train station that staff and students use.

# 4 DISCUSSION AND ROADMAP FOR URBAN HCI

Attracting the attention of users can be a challenge in a society that is hyperconnected, where people are predominantly occupied by personal devices, for example, smart phones, tablet devices and wearables, such as smart watches. When information is readily accessible people within public spaces are more likely to be focused on personal devices. This can include a range of activities, such as listening to music, social networking, work via emails and other productive platforms, or consuming media such as movies and podcasts. Our DUIs had some successes and some failures, from these we outline the following recommendations for future work to target (Figure 2).

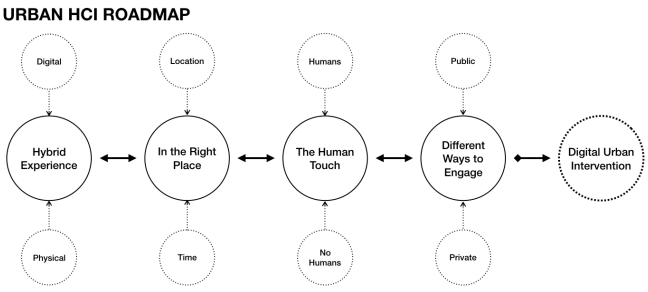


**Figure 2: The Urban HCI roadmap highlighting the key areas to be focused on in future work along with the factors that affect them.**

**The combination of digital and physical (The Hybrid Experience).** While digital technologies can augment the experience and provide controlled functionality, the amount of freedom the user has to express themselves is limited by the bounds of the system. However, physical non-digital forms of engagement tend to allow for greater freedom of expression. For instance, The InstaBooth enabled participants to interact through personal mobile devices where responses were displayed on a public screen. As an alternative interaction, participants could engage through a physical mechanism by freely drawing pictures or writing on a piece of paper, which was then displayed. Therefore, DUIs should employ a combination of digital and physical interactions in order to enable a hybrid approach for people to engage. Additionally, the inclusion of physical non-digital forms of engagement also has the benefit of not requiring power and can be an alternative should the digital engagements experience some form of failure [29].

**Being in the right place at the right time.** The importance of location has been highlighted by previous work [15, 32, 44]. Location can change the audience and dynamics of the interactions (outdoors needs to be rugged to handle sunlight, etc). It is critical to develop interactions that are appropriate for the local context and to also take into consideration the place, the demographics of urban dwellers, and time of deployment [19]. In the design and deployment of our InstaBooth and Pop-spot studies it was key to consider these aspects, in order to tailor the interactions, tweak timings, and to ensure they were aligned with other events and urban interventions.

**The human touch.** Although it is good to have digital technologies integrated into urban interventions, which in all of our cases showed that they can attract people, the cases also identified that it is important to have humans (staff) at DUIs to be a helping hand and spark discussion. To maximise the potential of having a staffed DUI, careful attention should be placed on what types of human interactions will take place and ensuring there is appropriate signage to provide a "call to action" when the DUI is unstaffed.

**Providing different ways to engage.** Although hyperconnected societies are on the rise, it does not necessarily mean that public and private forms of engagement should be siloed, rather they can co-exist and interact with each other [25]. Enabling users to engage in different ways can result in rich data being collected and allows the DUI a larger user base – as pointed out in work by Schroeter and Foth [36]. This is especially important for sensitive issues, such as politics [20, 38], as some users will want to silently voice their opinion, while others want to grandstand and be vocal about it. For instance, Hive enabled participants to have their own personalised private view of a public display, while also allowing them to anonymously engage with it through remote control interactions. In Pop-spot, participants could privately and anonymously tweet a voting message (yes or no) from their Twitter app to be publicly drawn by the chalk robot as a corresponding face (smiley or sad). In addition to that, people could take public selfies through a tablet device, where the captured selfie was then displayed on a screen for all to see. Therefore, DUIs should provide different forms of engagement to include people who do not mind engaging publicly, while also including those who wish to engage discretely.

# 5 CONCLUSION

Digital technology is improving at a rapid pace and is gradually augmenting spaces within cities. With this, the form of DUIs is gradually changing. This is evident from the expanding research that explores other form factors for technologies in public space, like drone displays [5, 35], digital projections [7, 21], and AR [24, 30, 31]. As technology becomes more accessible and affordable, these technologies may become a common sight within future cities and no longer a concept commonly depicted in sci-fi movies and video games. The rise of personal devices is gradually causing people to operate within their own media bubbles, only viewing content relevant to them. For example, Keiichi Matsuda[2] depicts an extremity of this, where AR melds digital content such as advertisements and other information into the periphery of ordinary people in a usable and socially acceptable form factor. The research in this paper has broader implications to the design of these future technologies as it is important they are relevant to individuals while also improving their experience and lives within future cities.

In summary, research on DUIs in urban HCI is still a growing field. However, it is becoming increasingly apparent that there is a major competition for attention between DUIs and the array of personal devices that individuals in today's society possess. Therefore, designers and developers need to continue developing and refining DUIs as technology progresses while also constantly re-evaluating the purpose of DUIs. This work has laid down a roadmap for future areas that need attention.

[2]Hyper-Reality by Keiichi Matsuda - https://www.youtube.com/watch?v=YJg02ivYzSs

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