

Designing and Embedding a Tangible Public Interface in the COVID Era

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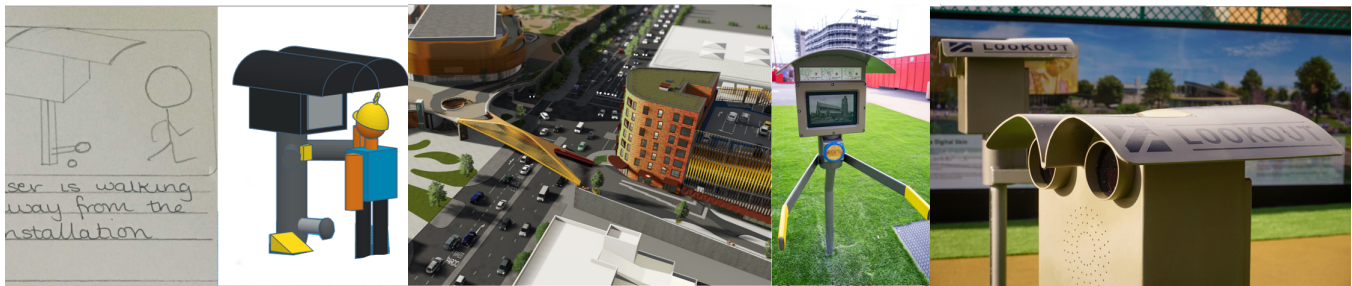


Figure 1: Storyboards, sketches and deployment for the Lookout project.

ABSTRACT

Due to public concerns over touch-based disease transmission, tangible and embedded interfaces are perhaps the most unsuited technology during a pandemic. Even so, this case study documents the development and evaluation of such a system from early 2020 when people were told to avoid actions that might spread the virus (e.g., touch). Adding to the challenge, the Lookout was installed outside in a city centre for widespread public use. Despite these challenges, a COVID-safe touchable device was embedded and extensively used. This Case Study reports the co-creation of the device noting COVID restriction adaptations over a nine-month deployment. Our contributions are twofold: the study acts as a case-point of the impact of the unique COVID design context, with lessons for future pandemic scenarios; and, given we had over 10,000 users at a time when people were cautious about using shared devices or services, we surface some design characteristics that can promote the use of public technology.

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CCS CONCEPTS

• **Human Centered Computing** → **Co-creation**; • **Public Displays** → *Civic Engagement*.

KEYWORDS

Human-Computer Interaction, public displays, public engagement, co-creation

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1 INTRODUCTION

Swansea city centre is currently undergoing a £1.35Bn investment aimed at regenerating the centre into an inclusive digital hub both for its citizens and visitors. The investment is one element of a broader regeneration project being overseen by Swansea Council and includes an Arena, Pedestrian Bridge, Coastal Park, Housing Complex and Car Park. Whilst residents were confined to their homes due to lockdown the city centre was undergoing this substantial transformation. This prevented them from being able to

gradually observe the changes of the space they once knew. Therefore, this case study focuses on how to design a tangible interface during a global pandemic that aids topophilia. The objective of the work was to develop, implement and evaluate a public display whilst exploring how it connects people with a sense of place. The final installation was named the Lookout - an interactive installation which provided a virtual window into the future development of Swansea city centre.

Swansea is a coastal city with many glorious beaches. Therefore, the inspiration for our design was a set of seaside binoculars that can see into the future of a space instead of the distance. The installation was envisaged before COVID hit, but it was designed, developed and deployed in the midst of the national lockdowns of the first and second waves of the pandemic. While this caused a range of difficulties, it did allow us to answer two key questions: i) how can we design a public technology that is “COVID secure”?; and, ii) given people’s reticence to interact at all in public, how might they be enticed to do so in a safe way? By detailing our experiences here, we hope to not only provide a starting point for public technology that is pandemic resilient, but also elicit insights into what can make a public technology more engaging.

Within our research we wanted to explore how technology could be used to enhance topophilia—an emotional connection with a place—within an urban space [19]. Urban spaces are areas in which communities have interactions and engagements with a variety of factors every day. Our design is an in situ installation enabling participants to utilise the installation at their own pace within a location relevant to the content, which has been shown to aid topophilia [18]. This case study focuses on user engagement and interactions with a new interactive device that provides information about a civic project. Engaging the public in redevelopment projects has been shown to be vital for integrating communities within urban planning and provides a convergence of ideas which can lead to positive community engagement [3, 8, 9]. However, many studies have focused on the use of a digital screen to evaluate engagement [1, 5–7]. In contrast, our aim was to create a novel interaction that enabled users to interact using COVID-safe elbow levers and buttons to view a variety of content and pulling away from reliance solely on large screens. In addition, co-creating designs with a community is more likely to lead to the creation of a design which is fit for the community it is designed for. This involves taking into consideration aspects such as the commitment levels a user is likely to provide, or their level of technological knowledge [2]. Within our study we have worked with stakeholders, community members and extra-ordinary users to create a design with the community, for the community. In discussions with these groups, we identified an installation that could provide engaging information about the new regeneration site in an interactive, COVID-friendly format, that would aid there topophilia within the new space.

The methodology used within this research was guided by participatory design approaches [15] as their goal is to work directly with stakeholders and users to design efficient technology for communities [16]. Throughout the research two stages have been completed: workshops for creation and discussion of physical and digital designs and a 9 month technological deployment where the following were completed: data logging and analysis, observations of use and user interviews.

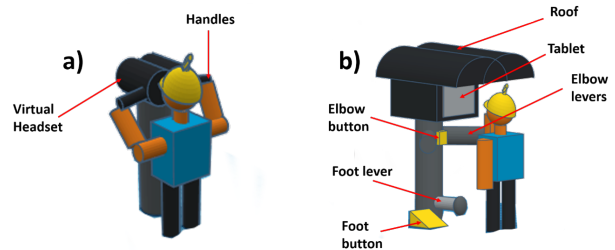


Figure 2: a) Initial Design, utilising a VR headset and handles to view immersive digital content. b) COVID-adapted design utilising a tablet to view digital content, with a roof to prevent glare, the model includes two possibilities for interaction (foot and elbow).

2 INITIAL DESIGN CONCEPT

At the beginning of the design process, we underwent a series of possible installation types that could be integrated within the city centre. These included interactive screens with Augmented reality similar to a design concept evaluated in Berlin [13] and a design concept inspired by Telescopr [17]. In this previous project, a user would place their face into a fixed-location Virtual Reality (VR) headset and be transported into the history of a local industrial heritage site [17]. Due to the higher accessibility of the Telescopr and its ability to withstand harsh weather conditions, it was chosen to be the best initial design. The Telescopr concept was based on a virtual version of binoculars often found in seaside towns, where a user could look into the distance of their location. In contrast, our project aimed to teleport the user into the future of the Swansea regeneration site. To ensure COVID-safety, two elements of the initial design (see Figure 2a) needed to be adapted the software used to display the content and how the user could interact with the content. A tablet was chosen as a suitable headset alternative for its image quality and larger surface area to enable the participant to stand further away from the device. To maintain the design concept of seaside binoculars and to prevent glare on the now larger device, a roof was added to the design (see Figure 2b). Finally, to enable the user to interact with the content without needing to use their hands, we proposed two options; an elbow-based and a foot-based interaction with both versions including a lever and button (see Figure 2b). As detailed below, the elbow levers were chosen as the most suitable interaction type due to community feedback.

3 CO-CREATIONAL WORKSHOPS

Over three months, seven workshops were completed: five Zoom based, one teleconferencing and one in person. The workshops aimed to retrieve feedback from stakeholders, community members and extra-ordinary users about the physical and digital attributes of the Lookout with a particular focus on inclusivity of design. A further underlying theme was the need to recreate a sense of place for communities re-entering the centre. This was achieved by creating storyboards illustrating the physical and digital design and the context of use which were used as prompts for discussion. The storyboards underwent 7 iterations upgrading from pencil-paper sketching to an Android Studio application.

3.1 Online Workshops

A team of 10 people external to the research team helped with our work, with five or more present at each online workshop. Their backgrounds ranged from cultural developer, regeneration specialist, major events leader and project director. Within the workshops, the users were shown a storyboard that prompted discussion and was adapted based on their feedback. These workshops aimed to create a unique opportunity to think about how users may interact with a new sense of place when we were unable to complete workshops within physical space. Participants broad spectrum of understanding provided us with an inclusive overview of Swansea city centre and its community, the redevelopment project, building and development, and the previous deployment successes and failures within the city centre. The online workshops were between 1 and 1.5 hours in length, where the digital and physical design of the Lookout was discussed using storyboards as prompts.

Adaptations were made to both the physical and digital aspects of the design based on the feedback received. The feedback and adaptations made included the following. The original physical design was inclusive of one installation at a set height for adult users. The participants suggested that children would need to be lifted by guardians to interact and wheelchair users would have no opportunity to interact. Therefore, two installations were designed at two heights: one for wheelchair users/children and one for adult pedestrians. In addition, the shorter installation provided space for wheelchair access (see Figure 3a).

Pictograms were suggested to explain to the user how to interact with the design, showing them how to interact using their elbows instead of hands or touching the screen to ensure COVID-19 Safety. Furthermore, it was suggested that each user might walk up to the content at different times within a cycle, causing a different experience. Therefore, a time out was introduced to ensure all users could interact with the content in the same way.

Throughout the digital content, the users could travel between locations, but this did not provide an immersive experience. This led to two adaptations: the incorporation of a picture-taking opportunity with the ability to add a variety of Augmented Reality (AR) filters and drone footage with teleportation filters to provide a sense of the scale of the regeneration project. Finally, roughly 10% of the Swansea population are Welsh-speaking [20], and therefore, the application was adapted to provide bilingual content.

3.2 Socially Distanced Workshop

A further on-site workshop was also completed with the redevelopment contractor, site manager, engineer and project director. This workshop discussion focused on the physical design of the encasing of the Lookout, including the possible dimensions and robustness. The original heights were reduced by 10cm to accommodate for the average height of females, and a robust metal (E.g. aluminium) was suggested to prevent vandalism (see Figure 3a).

3.3 Involving Extra-ordinary Users

A teleconferencing workshop was held with 15 members of Sight Life, a South Wales based charity that aim to help the partially and non-sighted to live independent, active, social and fulfilled lives [11]. The participants provided a specific perspective which

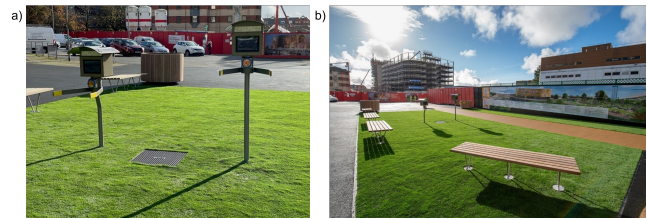


Figure 3: a) The Lookout final installation physical design Left: Design for wheelchair users and children at 1m height with wheelchair accessibility. Right: Design for adult pedestrians at 1.4m in height. b) Final deployment location with both installations shown, chairs and plants for bordering, information boards.

enabled us to make changes for all members of the community [10]. This workshop aimed to understand the communities' feelings towards the new development site and the installation. The concept, content and physical design of the Lookout were provided as verbal explanations to the group and based on the storyboards discussed above.

The discussions focused on two aspects: the physical design of the Lookout and the location it would be based in. For the physical design of the Lookout, the use of elbow-based and foot-based levers was evaluated (see Figure 2b). The participants suggested that the foot-based levers could become a trip hazard as their walking cane or assistance dog could not easily be noticed. The elbow-based designs which were chosen also provided an inclusive option for paraplegic participants. Several suggestions were made to create a safer area around the installation, including the use of colour and texture contrasts from the main walking path and planters/chairs to create a boundary for walking canes to pick up on. Figure 3b shows the final deployment area which includes AstroTurf under the installation area providing a colour contrast from the grey pathway and texture contrast from the concrete. Enabling partially sighted users to see which path is the walkway and helps non-sighted walkers to feel when they are no longer on the walkway. Chairs and planters were added surrounding the boundary of the AstroTurf to provide a barrier for users to know they are no longer on the path. In addition to this, several display boards surrounding the installation provided information about the development which could be read aloud to users unable to interact with the Lookout.

3.4 Outcomes

Following the seven workshops completed above, we have the following outcomes:

- Physical design adapted to be COVID friendly
- Second Installation added to ensure inclusivity
- Pictograms added to ensure users understood how to interact
- Personalised picture-taking opportunity added with AR filters
- System time out to ensure each user begins at starting screen
- Elbow-based interactions chosen instead of foot-based and surrounding designs adjusted to ensure safety
- Welsh-English option added

- System heights adapted to ensure more users were able to view the content

4 FROM DESIGN TO DEPLOYMENT

After completing the workshops, final blueprints were created to build the hardware and software aspects of the Lookout. The Lookout was adapted for deployment with both installations placed within the city centre from November 2020 until July 2021. The software design was identical for both installations and shown as follows.

4.1 Software

The software for the installation was created using an Android app. The tablet's inbuilt magnetometer was used to move the content on the screen in accordance with the movement of the elbow levers. For example, if the user pushed the elbow levers to the left, the content on the screen would pan to the left. To ensure each user had the same experience, the content would re-centre after each participant's interaction.

To help the users to connect the area with previous memories the content transports them from the past to present to future of the city. The interaction began with a starting screen showing a slideshow of pictures from Swansea city's past (E.g. Figure 5a) transitioning to a language selection (English/Welsh) and Augmented Reality (AR) filter selection menu where the user could push the elbow levers to view different filters augmented onto their face. When they were happy with a filter, they could select it using the elbow button which would take a picture. The filters included sunglasses, full face mask, crown, beard, moustache, masquerade mask and no filter. The user would then enter a selection screen showing the current view of the site with selection buttons above each area under regeneration (see Figure 5b), E.g. Arena (Location assets provided by Swansea Council). By pushing the elbow-levers left and right the user could hover over each location, including the Arena, Pedestrian Bridge, Coastal Park, Housing Complex and Car Park selecting the location they wish to visit. After selection, drone footage from the area of the installation to the area of regeneration was shown, transitioning a panoramic image of the future location with their personalised image shown (see Figure 4b). After viewing the location, the user would be teleported back to the selection screen, where a new location could be selected. After 15 seconds of inactivity, the content would return to the slideshow of Swansea's past.

4.2 Hardware

The Lookout needed an enclosure that was a robust, waterproof material which would not interfere with the magnetometer (see Figure 4a). The exterior of the installation was created using aluminium. It is a robust, waterproof metal that does not reduce the accuracy of magnetometer readings that control the movement of the screen. The design consisted of a pole to enable wires to be fed into the power sockets under the installation, a rotating centre comprising a spring to enable the elbow levers movement of 60° from left to right and finally, a tablet encasing with a roof. A rod of aluminium was welded onto the rear of the pole to provide extra support and prevent the pole from being vandalised.

Figure 4a shows the final rig design for the Lookout. The roof replicated the shaping of binoculars often found near the seaside. Its design prevented glare on the tablet and provided a distance from which users should stand beyond to view the full content and reduce COVID risk. A tablet was placed behind a glare preventing, shatter proof glass and bolted into place. The elbow-levers were placed 30cm apart to enable the user to either stand between the levers and move the installation with their body or use each lever separately. Moving the levers from left to right and vice versa, caused the content on the screen to pan from left to right showing more content. The elbow button was placed between the elbow levers and the pole and was visually similar to disability access buttons placed near automatic doors to provide a familiar interaction. In addition, the button was coated with an anti-COVID copper film [14]. The ends of the levers were painted yellow to ensure clear visibility for users walking by. Finally, the casing was painted with a golden hue similar to the Arena. The design for the wheelchair users/children's installation was adapted to enable a wheelchair to fit under the installation. Therefore, the pole was moved further to the rear of the tablet encasing with the elbow levers still placed at the front of the encasing to ensure easy access (see Figure 4b).

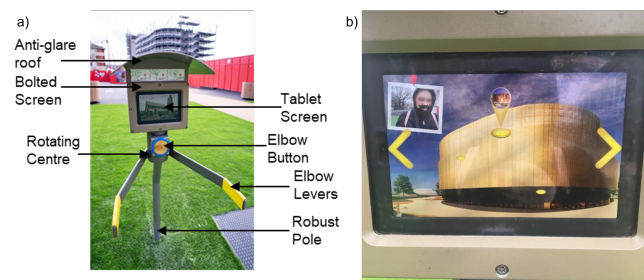


Figure 4: a) Final construction of the finished Lookout rig. b) Snapshot of a user viewing the Arena with their picture shown utilising the moustache filter.

5 DEPLOYMENT EVALUATION

A study of the Lookout was completed across a nine-month deployment (November 2020 to July 2021) where analysis of three interaction types was completed: logging data to understand how users interacted with different aspects of the content (no personal data collected), passive observations to understand users' behaviours when interacting and interviews to understand the success of the engagement and user views about future city-based technologies. The method for the interaction types and results are detailed below.

5.1 Logging Data and Observations

Logging data from every interaction enabled the Lookout to be deployed without constant supervision, enabling users to interact with the installation without worrying about the social distancing of a researcher nearby. This also reduced the possibility of the Hawthorne effect, where users adapt their behaviour due to awareness of being observed [12]. The data collected for each interaction included: the date of usage, time of usage, total time on the device,



Figure 5: The transition of content from the past to the present to the future of Swansea city centre. a) Swansea city aerial view 1940s post Blitz b) The current view of the development from the Swansea location with Arena highlighted (November 2020) c) The future view of Swansea city centre's Arena Auditorium with a users augmented picture.

locations visited, total time at each location, time out location, language chosen and filter chosen. Observations were completed from a seated > 2m distance to reduce any influence on users knowing they were being observed [12]. The observations consisted of analysing the general usage of the Lookout, inclusive of the number of users interacting together, the types of users interacting with the Lookout and the context of usage. These observations were used to understand how users interacted with the device, such as if they still tried to use the tablet as a touch screen device and evaluate how users interacted with others after utilising the device.

In total, over 10,000 interactions were recorded (6514 adult pedestrians, 4477 wheelchair users/children), equivalent to 5% of the local population [20]. In addition, 13% of users opted to interact with the minority language version of the two languages supported showing the importance of providing alternate options to improve accessibility. Participants spent roughly 2 minutes viewing the design's different aspects, with the Arena being the most visited location (94% visited). Participants using the adult's installation often visited a location more than once. Observations lead us to believe that many users interacted with the Lookout in pairs or groups and either took turns to interact or one user completed the main interactions whilst the other looked over their shoulder. By interacting in this way, they were able to interact in a co-experience compared to a singular experience, reducing the possibility of embarrassment and connecting new memories with those people to this new space. In addition, several children ran from the top of the high street down to the installations and interacted whilst their guardians walked towards them, then interacting together. When other adults observed families interacting with the device, they would often observe from a distance and then interact themselves once the family had moved on. Therefore, by interacting with the device, the families created an inclusive space for others to feel comfortable using the display without judgement.

The personalised picture-taking opportunity was top-rated, with 93% of participants choosing to use a filter. However, we observed that elderly participants, perhaps those who had not used social media filters struggled to understand how to select or interact with the picture taking opportunity. In addition, elderly users would often utilise the wheelchair user's/children's installation instead of the adult pedestrian's installation. When prompted as to why they had chosen to use the smaller installation, the participants said that designs created for children are often more accessible and

have more narration. The elderly users were often more likely to attempt to touch the screen to interact before utilising the elbow levers.

During the lockdown, essential workers would mostly interact with the Lookout during weekdays between 12pm and 2pm. This demographic was likely passing-by the Lookout on their way to purchase lunch from the nearby supermarket, one of the few shops to remain open. In comparison, when lockdown began to ease most interactions occurred on weekends, with the time of usage balancing across the hours of 9am-6pm. Figure 6 represents the Lookout usage for all participants and shows that interactions with the Lookout were proportional to the number of COVID cases within Swansea city (see Figure 6). The dates showing no Lookout interactions were when the system was out of order, often due to torrential rain causing excess moisture within the enclosure leading to the tablets being removed to dry.

5.2 Interviews

Two approaches were taken when completing one-to-one interviews at the Lookout: to interview participants who used the installation without prompting and to interview participants who were prompted to use the installation. The prompted participants were selected based on them glancing at the Lookout and therefore showing interest in the device. Users who utilised the display without prompting were chosen at random to be interviewed. Overall, 20 users (10 of each prompting type) were asked about their knowledge of the redevelopment site before and after interacting with the Lookout and what technologies they would hope to see within the city centre in the future. The interviews aimed to understand whether the Lookout content had been informative for the user and what other types of interactions they would hope to see within the city centre in the future.

User feedback suggested that due to their inability to enter the city centre during the pandemic the participants had little to no knowledge of the regeneration project. They found the Lookout to be informative and enjoyed the interactive nature of the design. Many noted the drone footage, as they were fascinated to see the scale of the project from a bird's-eye view. Interestingly, even as the structures increased and became more visible, users only expressed knowledge about the site once the Pedestrian Bridge was installed. The users said that they were utilising the Lookout to find out more information about the Bridge from this point on. The participants

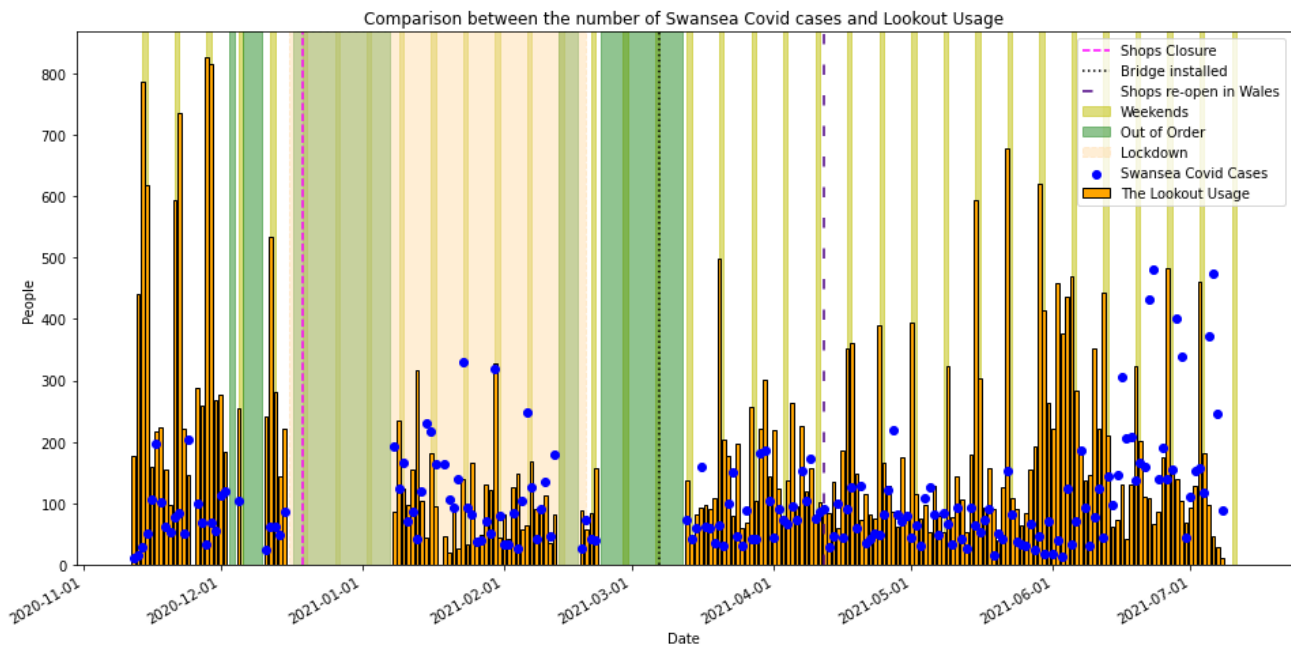


Figure 6: Graph showing the Lookout usage for all participants compared to COVID cases from 12th November 2020 to the 11th of July 2021

who interacted with the installation without prompting were happier to answer questions and often had several questions of their own about the Lookout project and the development deal.

The users were also asked about the types of technologies they would like to see within the city centre in the future. All were initially reticent due to their perceived lack of technology expertise (E.g. one user said, "I don't know I'm not good with technology"). However, after further prompting several mentioned that they enjoyed interactive technologies placed within an urban space for all to use. Several users also mentioned that if new technologies were to be incorporated, they would like them to be aimed around Swansea city's activities such as the annual shows, re-emphasising the need to make public interactions with and for the community. The most inquisitive users were families. When asked about the technologies they would hope to see in the city's future, they said they would like to see technologies for children/teenagers to interact with. Therefore, we hope to incorporate a broader range of technological activities for children within the centre in the future.

6 IMPACT, DISCUSSION AND FUTURE WORK

We see a real opportunity to utilise technology adapted and designed during a pandemic to aid in engagement and topophilia within a regeneration project. Throughout the deployment we found that a novel interaction type is vital for encouraging users to interact with an installation as they are interested in interacting with something new and therefore creating a new interaction with place [4]. By incorporating drone footage within our design, it was possible to provide a sense of scale which was effective in aiding the participants in understanding the development site and its new

locations. When completing civic engagement, it is helpful to enable the users to view the location as a whole and specific aspects of the site. We found that users enjoyed this aspect of the design.

Furthermore, we discovered that others perceived designs focused on children's usage as more inclusive and exciting to use. Therefore, creating a family-friendly design can create a universally accessible interaction that enables a broader range of users such as introverts and the elderly to feel more comfortable having a go at interacting.

One of the biggest challenges we faced whilst completing this work creating a physical, interactive design across workshops that could only be held virtually, meaning that we had little opportunity to ask users to interact with prototypes outside of the design team due to COVID restrictions. This prevented us from completing preliminary studies on how users thought they should interact with the design. In addition, midway through our deployment, a lockdown was imposed across the Swansea region from the 16th of December 2020 until the 19th of February 2021. This led to all non-essential shops closing and the community being confined to their homes. This caused the number of people within the city centre to drop rapidly and consequently the Lookout usage. However, the closure of shops enabled the observations of two different groups of users within the city: key workers still travelling within the city centre and all users returning to the city centre after lockdown. This enabled us to see how different users interact with such systems, with a clear contrast between working professionals interacting within lunch breaks during the week and families interacting as groups on the weekend.

Finally, we discovered that elderly users were more sceptical when interacting with devices as they were often left out of the design process. Therefore, adaptations would need to be made to enable all users to interact with the design, such as creating a separate screen with filter choices so all could be seen at once. When designing content, it is essential to evaluate the range of users interacting with the design and remember that a percentage of the population unfamiliar with social media trends and new technologies.

7 CONCLUSIONS

An interactive, immersive installation was created whilst adapting to a pandemic deployed within Swansea city centre for 9 months. The installation was co-created through a series of workshops with Swansea Council, developers, and community members. These workshops led to a detailed blueprint creation for hardware and software design, adapted and deployed into the city centre from November 2020 until July 2021. Analysis of the data found that the public wants to engage with a civic Lookout and enjoy interactive, immersive experiences that have been tailored to their communities. The displays were created to be as inclusive as possible, with wheelchair access included and the Sight Life charity consulted to create a safe interaction zone.

Two broader lessons can be taken from this work. Firstly, a wide range of demographics with a specific emphasis on children and elderly users should be incorporated into the design process of public displays to ensure equal interaction opportunities. Secondly, public installations can produce positive engagement with civic projects such as the Swansea regeneration project.

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