Fontana: Triggering Physical Activity and Social Connectedness through an Interactive Water Installation

Loes van Renswouw
Eindhoven University of Technology, Eindhoven, the Netherlands
l.m.v.renswouw@tue.nl

Yvonne van Hamersveld
Eindhoven University of Technology, Eindhoven, the Netherlands
y.m.v.hamersveld@student.tue.nl

Hugo Huibers
Eindhoven University of Technology, Eindhoven, the Netherlands
h.huibers@student.tue.nl

Steven Vos
Eindhoven University of Technology; Fontys University of Applied Sciences, Eindhoven, the Netherlands
s.vos@tue.nl

Carine Lallemand
Eindhoven University of Technology, Eindhoven, the Netherlands; University of Luxembourg, Esch-sur-Alzette, Luxembourg
c.e.lallemand@tue.nl

ABSTRACT

Promoting healthy and active lifestyles is an important objective for many governing agencies. The design of active urban environments can be an effective tool to encourage more active behaviors and water features can attract people, improving their experience of the urban space. To explore the potential of these concepts, we designed Fontana; an interactive public installation that aims to stimulate physical activity and social connectedness in the urban outdoor space, using the multidimensional attractiveness of water. We focus on the use of embedded interactive technology to promote physical activity, using water as a linking element between users. Adopting a research-through-design approach, we explored how such installations can nudge people into an active behavior while additionally strengthening social connectedness, using inclusive design principles. We report on insights gathered through this case study and findings of a preliminary user test, discussing the implications of this work for design researchers and practitioners.

CCS CONCEPTS

• **Human-centered computing**; • **Human computer interaction (HCI)**; • **Interaction design**;

KEYWORDS

Human-environment interactions, interActive environments, physical activity, social interaction, urban design, inclusive design

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1 INTRODUCTION

Physical inactivity and associated health concerns are a major societal challenge in modern western societies [2, 13, 33]. Promoting and supporting active lifestyles is therefore a timely and popular topic in multiple research fields and public policies. Through their design, urban environments can contribute significantly to stimulate people to be more active [15, 26]. We see potential for this in active environment design [6, 14] and the continuing shift towards human-environment interaction (HEI) [29, 31], where technology is increasingly integrated in the environment and is therefore both more omnipresent and less noticeable.

With their unique motion, plasticity and reflections, water features are popular elements in landscape design [19]. Water can be used to attract people of a wide age and background range [34] and create either a calm or exciting atmosphere [19].

Building on this knowledge, we designed Fontana, an inclusive interactive water installation that stimulates physical activity in a fun and social way. We explore and showcase the use of embedded interactive technology to promote physical activity, using water as linking element between different users. With Fontana, we contribute to research on how human-environment interactions in the public infrastructure can encourage people to be more physically active. We focus on the potential of water for designing interActive environments, and how to strengthen social connectedness while adopting an inclusive design approach.

2 RELATED WORK

2.1 InterActive Environments

Uniting the persuasive powers of urban environment design and HEI technology, van Renswouw et al. (2021) defined the concept of interActive environments [25]. These smart environments use the combined potential of both fields to encourage people to be more physically active. With their intelligent technology embedded in the public space, interActive environments can adapt to different users or circumstances. They are accessible to all passers-by without any prior investment, including those who are not deliberately trying to change their inactive lifestyle. This makes them more inclusive than other technologies to increase physical activity [25]. Examples of such environments aimed at triggering healthy behaviors are

Discov [24] or Sensation [23]. Discov is a network of interactive waypoints placed in a public park. By triggering curiosity and exploration they provide a fun and challenging walking experience [24]. Sensation is an interactive path that matches natural sounds to people's footsteps to provide a more enjoyable and relaxing environment [23].

In-context use and effects of such interventions can be studied using a research-trough-design approach [35], specifically the Experiential Design Landscapes method [17]. This design research method takes the design process into people's natural, everyday environment using smart probes to learn about user behavior as can be seen in the Social Stairs project [21]. This example of an interActive environment with a strong social component was installed on a staircase in a public building, persuading people to take the stairs rather than the elevator. Next to increased stair use, the researchers found a distinct social engagement that encouraged even more active behavior, such as jumping and dancing, and attracted more users. A second iteration rewarded social behavior with a richer, more dynamic sound experience. The social aspect added to both 'trigger' and 'motivation', which together with 'ability' are the main factors needed for behavior change to occur [7].

2.2 Designing with Water

From village wells to impressive statements of vision, power and identity, water features have combined and provided spaces for social interaction and sense of belonging throughout urban history, 'sustaining' communities [30]. Water is also rich in symbolic and religious values [16]. This explains the attraction of water features over different cultures and the varying social activities taking place around them. They are therefore effective design 'tools' when creating collective social space [30]. Next to their visual and social appeal, water features also provide a multisensorial experience and increase the pleasantness of an environment. Water plays with light and shows wind or vibrations on its surface [16]. Its distinct soundscape can mask unpleasant noise such as traffic [8], and running water causes a cooling feel while helping to accelerate ventilation and remove traffic fumes, providing a fresh smell [34].

Designing with water requires dealing with its dynamic nature, multisensoriality and the special relation people have with this element [16]. Attraction parks often include water games or water shows as their most popular family activities. But even rather simple interactions can evoke surprisingly engaging experiences [5]. Think about the playfulness of walking in the rain, jumping in puddles or splashing in water. Many art installations also play with the fascination created by water. In the Rain Room by Random International (2012) visitors are simultaneously exposed to and protected from the water falling all around with a rain effect. Through the use of 3D tracking cameras, visitors experience the sight, sound and smell of rain as they navigate the space, while still remaining dry [22].

We reviewed several publications describing the design process of interactive water installations, which use water as an organic or embodied interface [5, 9, 11, 20]. Authors report playfulness as a core element of the user experience [11, 20], with water interfaces reminding people of both the risk and thrill of children's water games [9]. At the same time, water can be used to emphasize association with nature and create holistic and multimodal experiences [5]. Nasar and Lin (2003) measured human responses to different types of water features. Although both still and moving water features are perceived as pleasant, there is a preference for jets and combined features, which are also regarded as most exciting [19].

Curiosity can be an important motivator for interaction [27, 32], as can be seen in the public installations City Mouse, placed on a public square in Oulu city, Finland [11] and Water Games, featured at the Universal Forum of Cultures event in Barcelona [20]. For both designs, participants were exploring options and interactions, desiring to figure out the different interaction opportunities. Supporting this exploration and discovery can further amplify the curiosity of participants and so keep them engaged longer [24, 27]. The City Mouse and Water Games installations each allowed multiple users to interact simultaneously and even to work together to reach a common goal. This shows the potential of water installations to effectively facilitate social interaction. Both installations also demonstrate the attraction of such water features; Water Games had a high number of users per hour compared to other interactive installations mentioned in their paper and City Mouse engaged and attracted users from all age groups, though more children actually interacted with the installation.

2.3 Inclusive Design

Public spaces and services benefit greatly from inclusive design principles, because they are meant to be used by anyone [4]. For this work, we therefore aim to adopt a user-aware design approach; pushing the boundaries of 'mainstream' to include as many as possible, regarding users with divergent requirements as 'normal but different' [4, 28]. Eliminating barriers enables inclusive use, while at the same time displaying progress towards social justice [28]. Designers therefore need to understand desires of a wide range of user groups and respond to this diversity [28]. For older people, for instance, good designs can help to maintain or improve physical independence, yet factors as reduced sensitivity, hearing and vision need to be acknowledged. Messages and interactions should therefore not rely on one sense, but rather a combination of modalities, such as audio and visual signals [4]. As emphasized in the Microsoft Inclusive Toolkit [18], "disability happens at the points of interaction between a person and society. Physical, cognitive, and social exclusion is the result of mismatched interactions. As designers, it's our responsibility to know how our designs affect these interactions and create mismatches." Inclusive design is key to address permanent disabilities but also temporary and situational limitations (e.g., a parent holding a baby, thus not having their hands free).

Simultaneously, designers cannot create without barriers, because they are inherently part of the physical –and virtual– environment. Creatively approaching these existing barriers to realize enabling environments is thus an important goal in inclusive design practice [28]. By removing barriers and including different user groups, inclusively designed interactive installations also provide the opportunity to increase social connections and to support collaboration between these groups. A social component can create a richer, more fun (interactive) experience. Working together will enhance the sense of inclusivity while increasing understanding and empathy between different user groups.

Figure 1: Examples of sketches using water as an interaction modality triggering social connectedness

3 DESIGN PROCESS

Combined with our literature study, we reviewed engaging public installations as source of inspiration [25]. Analyzing their design principles, we found that social interaction and collaboration are important elements in the success of these types of installations. As many existing interactive public installations are targeting children, there is an opportunity to expand their reach by designing for a wider age range [25]. We also observed that installations mostly focused on able-bodied people, excluding those with special needs. We decided to focus our design process on inclusivity, aiming to prototype an engaging and playful installation which could be used by a variety of users.

3.1 First Explorations

We explored the solution space through sketching potential solutions, some of them revolving around the interaction with water (Figure 1). Inspired by the concept of public installations triggering social interactions, we included playful collaboration features.

To increase our understanding of inclusive design, and empathy for potential target users, we placed feedback requests in five Facebook groups, including three groups for people with disabilities and/or elderly people and caregivers, a group for designers and a general audience group. Based on a short description and visual impression, we invited people to comment on what an interactive public water installation to trigger physical activity would ideally look like, and what to consider for their specific needs as a potential user. This included the overall concept, types of interactions they would prefer, issues they predict, specific needs or design requirements and additional open feedback.

Key takeaways included the importance of safety, such as using anti-slip materials where necessary and providing clear distinctions between wet and ‘safe’ areas to prevent unwanted stimuli or panic, but also adding calm spots to enjoy the spectacle. In line with literature, respondents also suggested to increase clarity and accessibility by using multiple types of in- and outputs; triggering multiple senses by including sound, light, color and varying textures; and different kinds of fountains to attract a broader audience.

We created a small-scale prototype to get familiar with technical aspects, interaction and output of such an interactive water design. Too small to conduct a representative user test, this prototype along with a rendered video impression of the concept was presented to 10 design experts with backgrounds in HCI- and industrial design to gather feedback. Important insights were a high preference for more diverse and complex interactions, and exploring and implementing effective, engaging ways to create an inclusive experience, specifically compared to regular fountains or splash parks for children. This also resonated with the conclusion of our initial benchmark exploration, which showed limited examples of interactive environments for target users of all ages. Experts also stressed the importance of considering that the degree to which people actually want to get wet when interacting with a water installation varies a lot for different user groups or use contexts. For instance, it might be acceptable during a summer day at an attraction park, yet less so when commuting to work in the morning or when weather conditions are not adequate. In line with the inputs we gathered from the online groups, this can be addressed in the design in several ways: giving the impression of water without the risk of getting wet (as in the Rain Room described in Section 2.2 [22]), playing with aspects of water that do not involve wetness (reflection games, skimming stones), including a sort of progression in how “splashy” parts of the installation are, or simply by clearly indicating dry and wet areas.

4 FONTANA

Fontana is a prototype of an interactive public installation that aims to stimulate physical activity and social connectedness in the urban outdoor space, using the multidimensional attractiveness of water. Through different interaction possibilities and inclusive design principles, it targets users with a wide age and diversity range, encouraging them to work together. Building on the ubiquitous attraction of water features [16, 30], Fontana uses water as a universal, fun and inspiring design element to connect people and encourage physical activity.

The design consists of multiple fountains and pressure sensitive floor tiles on a hard flat surface. Users can interact with the fountain by stepping, jumping or rolling over the tiles around the installation (Figure 2).

As Fontana is meant to be an interactive environment in the public space, anyone present should be able to participate, making inclusivity an essential design goal. Fontana accommodates

Figure 2: Fontana concept impression – render created in Planet Zoo (Frontier Developments 2019)

Figure 3: Pilot test setup: a) first iteration WoO setup; b) synchronized interaction with second iteration prototype

different users by including several interaction modalities. The pads respond to jumping and stepping as well as strolling over or tapping on them. The pads are clearly recognizable through their color, circular shape and waved texture. Additionally, accessibility is optimized by keeping the installation level with the surrounding area.

4.1 Pilot Study

To explore how users engage individually and in shared encounters [12], we used an iterative prototyping process. As a first iteration, a simplified prototype was built using a submerged pump with a height control valve to generate and control the waterflow of a single, small fountain. We used convenience deployment [12] and a Wizard of Oz setup, simulating the interaction by manually controlling the height and power of the fountain (Figure 3a). Since this setup only entailed one fountain, the collaborative use was rewarded by repeatedly turning the fountain on and off several times. Observations were made and noted using guidelines for live observations [10]. Afterwards, participants were interviewed to learn about their experiences and other feedback to improve future iterations.

The onboarding interaction was perceived as unclear. Participants (N=12) were confused about what to do, some not even noticing the interaction pads. Only one participant spontaneously approached the fountain and started interacting, the others first came to us for clarification (n=5) or were invited to participate (n=6). With only a slight difference between single and collaborative use in this prototype, groups showed disappointment or confusion when collaborative synchronous use did not give the expected output. Overall, the groups interacted longer than individuals, but none stayed engaged longer than five minutes due to limited possibilities. Participants additionally indicated that the interaction pads and entire setup should stand out and be more inviting, clearly showing interaction possibilities to engage passersby.

To further explore the user experience, we conducted a pilot study with an improved prototype with semi-controlled deployment [12]. All participants were adults (N=19), including 5 older adults, and representing mixed cultural backgrounds. The main aim was to evaluate three interactions: onboarding, repeated interaction and synchronized collaborative interaction (Figure 3b). The new prototype included a much stronger fountain (Figure 4), which was remotely controlled by pressure sensitive floor tiles. The fountain was surrounded by three tiles as interaction points. Again, observations were made and participants were interviewed afterwards.

For this iteration, onboarding happened spontaneously, with passersby stopping to try out the prototype and exploring different interactions. Most participants (n=11) showed excitement when the fountain responded to their inputs. Groups (n=9) naturally started synchronized use after first having some individual interaction. Interestingly, participants were not just interacting with one tile; they were also frequently changing between tiles. Two groups of

Figure 4: Pilot test setup: full prototype

participants invited friends to join in, but none of the participants invited strangers to join. Due to the different interactions to be explored, users stayed engaged longer than during the initial test, with sessions lasting around 10 minutes.

From both the observations and interviews, we see that the fountain sparked exploration and imagination. Participants enjoyed the freedom and playful exploration to find out what was happening and were enthusiastic about the concept and possibilities. Looking at the difference between both tests, we expect that using more fountains or other techniques to show varying outputs for different types of interaction will further stimulate exploration and imagination of users, lengthen the interaction and encourage collaborative use. One important comment around the idea of inclusive design was that the tiles were decorated with footsteps used as nudges to indicate that the tiles were offering the possibility to step on. However, these footsteps might for instance not look inviting or inclusive to wheelchair users or a parent with a stroller. A reflection on how to represent inclusivity in our nudge is needed: what we aim for is that people understand intuitively that tiles would react to stepping, jumping, or rolling on them.

4.2 Interaction Scenarios

Based on the pilot studies and design explorations conducted, we defined several interaction scenarios for the next prototype of Fontana. Several layers of interaction accommodate different types of users and stimulate both individual use and collaboration (Figure 5). The varying feedback and increasing difficulty of collaboration can also help to engage users for a longer time [3].

5 DISCUSSION AND FUTURE WORK

InterActive environments can play an important role in encouraging physical activity through their design and ability to adapt to different users or circumstances [1, 25, 29]. Since they are also more accessible than other available solutions [25], these environments provide a good base for inclusive design solutions. In this research we therefore focus on the use of embedded interactive technology to promote physical activity, combined with inclusive design practice.

While existing interActive environments often target a specific user type, such as children or sporters [25], we focus on including users of a wide age and diversity range by using inclusive design principles. We designed Fontana, an interactive public installation that uses the attractiveness of water and playful elements to encourage physical activity and social connectedness in the urban outdoor space. Through Fontana, we research the potential of using such a physical, environmentally embedded installation when designing for behavior change, and specifically the use of water in this context. With this design we aim to encourage playful interactions, and so help people to embed enough physical activity into their daily lives. Next to physical activity, the installation also stimulates collaboration, which potentially enhances the interaction, lengthens the engagement, and most importantly brings together different user groups. This in turn strengthens social structures and inclusivity.

From our explorations we saw that small adjustments –such as indicating 'safe' and wet areas– can strongly impact the inclusivity of the design. This shows that empathy for and involving people with different needs in the process is essential when designing inclusive environments. While aiming for universal inclusivity, awareness of the existing barriers that inherently come with each

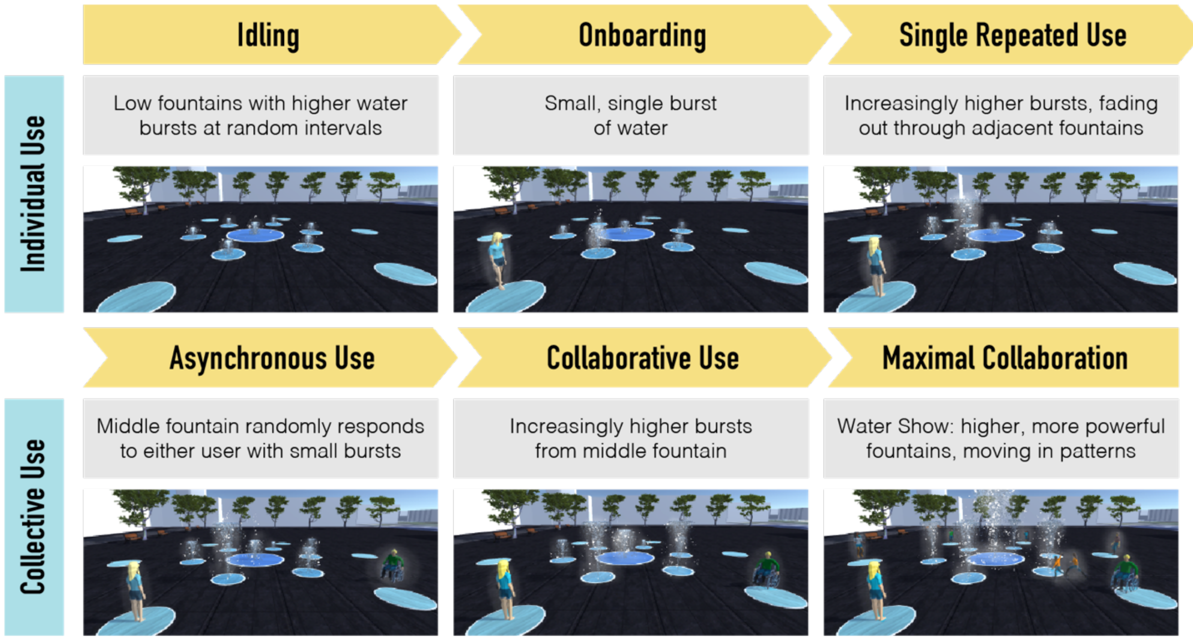

Figure 5: Fontana interaction scenarios

design is also an important mindset [28]. For Fontana, while already including users with a wide age and mobility range, limitations still exist for people struggling with social situations or strong stimuli. In our future work, we will continue involving people with varying needs to further increase the inclusivity.

For the next stage, we aim to use the Experiential Design Landscapes method [17] to explore the behavioral effects of Fontana on social connectedness and physical activity through in the wild deployment [12], collecting additional data from the pressure sensors. This allows unobtrusive study of spontaneous user and passerby behavior in a real-life setting which is essential to research our assumptions about user engagement and social impact. It will also help to include a broader audience, with participants of different ages and degrees of disabilities. This is important to test and improve the designed inclusivity features. Though short-term collaboration with strangers is a first and easily observable step towards social connectedness, long-term implementation and observation would be needed to indicate actual increased social coherence as well as possible novelty effect.

We will further iterate on input and output modalities, ensuring an inclusive character of the design and exploring effects of different types of fountains or other water features as well as different types of nudging to embed the notion of inclusiveness. Reviewing both permanent and situational limitations systematically using the Microsoft Inclusive Activities toolkit [18] will further contribute to our investigation and the quality of the final design.

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