Designing Interfaces to Experience Interactive Installations Together

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Abstract

Researchers at the *Making Culture Lab* use ethnographic methods to study how interactive technology supports digital practices in diverse cultural environments. This paper reports on how certain design aspects of display systems implemented in public space can induce social encounters and awareness. Field observations made since 2012 show that interface design may be a key factor in structuring such shared experiences. In 2014, HCI researchers introduced the Social Natural User Interfaces (Social NUIs) analytical framework to help HCI practitioners design interfaces that better support collaboration and cooperation in co-located multi-user interaction scenarios. This study describes four interactive media façades deployed in Montréal's Quartier des Spectacles to suggest that electronic artists intuitively anticipated the Social NUIs relational approach to interface design. Analyses highlight how the artists used crossmodal interfaces – also based on intuitive modes of interaction such as gesture, touch, and speech – to design interactive installations that engage people beyond the ubiquitous single-user "social cocooning" interaction scenario. The aim of this research is to illustrate how artistic architectural-scale digital public display installations has the potential to parallel, drive, and contribute to, socially concerned design thinking.

Keywords

Interface design; interactive displays; crossmodality; natural user interfaces (NUIs); Social NUIs; public space; urban interventions.

Introduction

While Huhtamo traces the history of public media displays to Ancient Rome, he further claims that it is the invention of electricity that saw dynamic displays and media façades make their appearance in public outdoor space. As far back as the nineteenth century, incandescent bulbs were used to illuminate advertising billboards while magic lanterns were used to project images on screen surfaces, walls, and public monuments. [1] Although today, these media platforms are electronically engineered, they often tend to serve similar purposes; typically, they are used to publicize commercial content, news, and location-relevant information.

Likewise, Manovich argues that digital technology has borrowed from older traditional forms – such as print and cinema – to remediate new media objects into *cultural interfaces*, a concept he defines as computerized screens that encode culture in digital form. [2] Because digital screens can now be used to mediate action and control, the design of cultural interfaces presents significant challenges with all new implications that reach far beyond issues of representation. [3] A case in point is how unleashing their interactive potential at the scale of the built environment might redefine people's everyday experience of the city.

Relatedly, contemporary artists are using the *crossmodal* properties of new media to experiment with large display installations as a media platform that can transform perceptions from one sensory modality to another. [4] For instance, *MindWind* uses ambient traffic noise (audio input) to trigger movement in an architectural-scale video projection (visual output). [5] The artist's stated intention is to use "elements that are part of our everyday environment to reconnect people to their sense of place." [6] Mediating one sense-impression into another also evokes an invisible link between the natural world and the transcendental.

Since 2012, the *Making Culture Lab* has been investigating such creative uses of dynamic digital displays in public space with a focus on understanding how new media artists are harnessing the interactive medium-specific potentials of screen-based systems to induce new forms of encounters and awareness. Field findings show that interface design may be a key factor in structuring such shared experiences.

Recently, the *Social Natural User Interfaces* (Social NUIs) analytical framework was introduced to the field of human-computer interaction (HCI) to help practitioners design interfaces that better support collaboration and cooperation in co-located multi-user interaction scenarios. [7] Social NUIs support a relational approach to interface design against the deeply ingrained technocentric orientations that have largely driven this research in past decades.

This case study describes four interactive media façades deployed in Montréal's Quartier des Spectacles to suggest that new media artists anticipated the Social NUIs relational approach to interface design in their screen-based artwork. In so doing, they may have paralleled, driven, and contributed to socially concerned design thinking by conceiving crossmodal interfaces that invite and engage people to experience interactive installations together.

Qualitative Field Study

Since 2012, we have been applying a multi-sited approach to the study of interactive media in public space with a focus on investigating the creative uses of dynamic digital displays. Our objective is to gather field data that will help

generate design knowledge on interactive display-centric technology deployed in urban environments. The following describes the research methods applied in this field study.

Methodology: Multi-Sited Design

The research methods used in this empirical study are derived from multi-sited design, an approach that draws from HCI, the social sciences, and the humanities. This emerging constructionist methodology is rooted in Scandinavian practices of participatory design as well as in multi-sited ethnography. [8] Participatory Design is a set of methods used in HCI to engage people in collectively participating in the design of the computer systems they use in the everyday. [9] Multi-sited ethnography is an interdisciplinary critical approach, which consists in conducting research in multiple, distributed, and shifting (micro) locales to later be analyzed against the contours of the overarching (macro) context that comprises all of the sites under study. [10]

Multi-sited design is a research strategy that can support thinking through making within the rapidly shifting socio-economic global context in which art and technology are being produced today. While traditional ethnography typically sees one or sometimes several ethnographers describe a single, well-circumscribed site, in a multi-sited approach, many researchers can be sent to collect data in multiple sites. [11] These sites are not only defined by their physical locations. They can be events, artifacts, narratives or even stakeholders. Further, such a method can allow researchers to compare the shifting and multiple virtual sites of representation that exist in online environments to situated sites.

By triangulating this data, a researcher sets out to sketch a broad picture or narrative, which exposes the web of complex relationships needed to create conditions conducive to the emergence of artistic creations or advances in art, science, and technology. In our research, the sites under study were made up of four art installations analyzed as situated events, which served as the locus of interactions between concerned stakeholders. By tracing connections between these sites, we attempted to identify design trends.

In this particular field study, data was collected while conducting non-participant observations of several interactive art installations deployed on some of the nine media façades of Montréal's Quartier des Spectacles, including first-hand field observations and notes, interviews with stakeholders involved in these projects; and a survey of the audio-visual materials that documented these artworks. In its broader context, this study was the exploratory phase of a latitudinous research that relied on participant observation and involved other places, stakeholders, artifacts, and events unified under a common thread: design knowledge.

Meta-Site: Montréal's Quartier des Spectacles

The past decades has seen major urban renewal projects undertaken all around the world to potentiate the new knowledge economy's "creative cities" by rebranding them as attractive and innovative cultural metropoles. [12] It is in this context that Montréal's Quartier des Spectacles came to operate nine media façades, wired connections, and a free wireless network within the boundaries of their one square-kilometer district. This permanent digital infrastructure enables artists to explore ways to catalyse public interaction and showcase their interactive public art pieces.

The deployment of such electronic artifacts is facilitated by ten kilometers of fiber-optic cables laid out underground to connect the master control room to strategic emplacements throughout the Quartier des Spectacles. Because this robust setup can support the real time transfer of massive data flows, it ostensibly encourages artistic experimentations in public space. Indeed, the Quartier des Spectacles announced in 2014 their intention to activate their nine outdoor media façades as a *digital urban laboratory*. [13]

Our field study considers some of the more interesting innovations that took place around the first instantiation of the *Digital Pathway*, a digital arts event during which interactive display artifacts were simultaneously deployed on some of the Quartier des Spectacles's nine media façades.

Key Approaches to Interface Design

While the last part of this study presents a detailed description of each of the four architectural-scale electronic art installations selected for analysis, the following section expounds the theory that guided our *post hoc* analysis of these artworks. Accordingly, it offers a selective overview of HCI approaches and concepts related to interface design to inform our discussion on interfacing devices used in digital art installations that include public media displays.

Crossmodal Experiences and the Digital Arts

While it can be said that each media technology offers its own ways to extend or compress the way we perceive, experience, and act within the matrix of time and space, it remains that today's screen technology comes with an unprecedented affordance. [14] Because it takes the form of digital data, it is now possible to transform media content into other media types, forms, and sensory modalities. [15]

Rendered possible by electrons – the very substance that digital information is made up of – this phenomenon is known as *transduction*, a three-step process which consists of, first, capturing raw data in the form of input; second, processing this data according to a set of prescribed protocols; and third, outputting it into an altered state. [16] Insofar as this characteristic of new media enables the conversion of one sense impression into another, digital art can be said to be a medium that supports crossmodal interaction.

But is this crossing over of sensory perception a novel phenomenon in people's experience of art? Merleau-Ponty claimed that everyone has a "synaesthetic perception" of their environment [17]. Notwithstanding that at any given moment, some sensory impression may overpower others, he purported that perception occurs through a "phenomenal field" in which different sensory modalities intermingle and mutually resonate with one another as sensory impres-

sions are experienced. [18] For instance, we can feel the softness of a fabric without touching it or hear the thump of a falling body even when it is observed without sound.

Many works of art defy Aristotle's concept of sensory discreteness, which suggests that we perceive an object according to the sum of the discrete sensory modalities it stimulates: its edges appeal to our sense of vision *and* its sound to our sense of hearing, *and* its texture to our sense of touch. [19] Not only does the experience of art tend to confound sensory modalities, but many artists have learned to use materials, colors, forms, and aesthetic strategies to produce artwork that stimulate perception across several senses or indirectly awaken one sense through another as when a sound is heard, or imagined to be heard, in response to a visual stimulus. With most media, this effect is achieved by association, metaphors, and evocative designs.

Artists working in new media, however, can use the principle of transduction to draw attention to how sensory impressions mutate into one another or trigger percepts across modalities. In fact, the science of electronics allows today's artist to expose this process in material form. In this sense, digital media lays bare the mysterious connection between the intangible and the tangible, the invisible and the visible, or the imagined and the experienced. Insofar as new media interfaces can make manifest how senses interact with one another, creating crossmodal interactions can become a means to expose these poetic relationships.

Further, because new media makes it possible to hypostasize crossmodality in works of art and because electronic artworks are conceived around this affordance, one could say that transduction constitutes a medium-specific property of digital art. [20] Indeed, most of the large-scale display installations described in this study proposed interactive experiences that remediated inputs across sensory modalities. In truth, this design feature has become so pervasive in the objects we use in everyday life that we rarely give it a second thought. Seeing, hearing, and feeling are now routinely combined in one of the world's most ubiquitous devices: the portable phone. [21] This becomes evident when it lights up, plays a tune or vibrates to alert users that there is an incoming call or a given location is close. [22]

This not only suggests that input and output are to digital art what brushstroke, color, and surface are to painting, or what light and contrast are to photography, it also implies that *interface design* constitutes a key factor in how new media objects shape aesthetic experiences. Interfacing devices are the membrane through which input and output are expressed and modulated – and although sensor and actuator technologies make up their nuts and bolts, in the end, user experiences are structured by interfacing strategies.

The field research we conducted on interactive display installations in Montréal's Quartier des Spectacles suggests that electronic artists often accidentally stumble upon unusual and innovative interfacing strategies in their creative work. Our review of the literature also shows that as far back as the early seventies, artists such as Peter Campus, Vito Acconci, and Bruce Nauman pioneered large-screen interfacing strategies by experimenting with human-scale video art installations. [23] The work of these legends and many lesser known artists arguably anticipated interface design thinking. The next section examines scientific trends in this area. This overview of the literature will be used to frame our discussion on examples of practice in art.

Natural User Interfaces (NUIs)

One of the major research trends in HCI is driven by the concept of *Natural User Interfaces* (NUIs), which proposes to rethink interface devices so they are responsive to "more natural forms of interaction such as touch, speech, gestures, handwriting, and vision" [24]. The assumption that underlies this approach to interaction design is that NUIs are said to be more intuitive and usable because they are arguably better adapted to everyday human actions, and thus more natural and easier to use. NUI advocates believe that developing interactions around a wider range of input modalities will enhance interactants' sense of power, offer better opportunities to design new forms of interactions, and more holistically blend users' actions with technology.

Because every new human-computer interface typically presents its own set of challenges and learning curves, Norman argues that natural user interfaces are not inherently natural, but certainly useful in enriching the existing repertoire of interaction techniques by adding more touch-based, gesture-based, and speech-based interaction to the existing arsenal. [25] In the same line of thinking, Wigdor and Wixon argue that adopting a NUI approach effectively multiplies expressive capabilities. [26] These remarks speak to the fact that interface design is not only a determining factor in what is *vs.* was is not possible in the realm of human-computer interaction, but also in that of art.

Design Approaches for Large Display Interfaces

In relation to screen technology in particular, Müller et al. offer a detailed taxonomy of design factors that support interaction including cognitive factors, interaction phases, interaction modalities, and mental models such as conceiving public displays either as posters, mirrors, windows or overlays. [27] Others metaphors that have been proposed to conceptualize the design of interactive public displays include *public notice areas* [28]; *community gardens* [29]; *theatrical stages* [30]; and *digital soapboxes* [31].

Beyond these dimensions, there are two aspects of large public displays that define them as a distinct type of interface: first, they can and are often used by more than one person, and second, they are deployed in a public context. Accordingly, design concepts and frameworks that place an emphasis on these seem particularly well-suited to developing the interactive potential of displays. This is the case, for instance, with the concept of *Shared Encounters* defined as spontaneous forms of communication and interaction that can take place in public places through technology [32]. More to the point, *shareability* is a concept that proves useful in operationalizing interaction in terms of entry points and access points in multi-user interfaces. [33]

The past few years, however, have seen a new approach emerge that is premised on this very idea of shareability in conjunction with that of natural user interfaces. Known under the moniker of *Social NUI*, it aims to facilitate thinking about multi-user interface design at an abstract level.

Social NUIs

Several HCI researchers have been concerned with the idea that NUIs are too focused on the single user's relationship with the interface and by extension, the system. Many of the researchers that have developed this framework are from the field of computer-supported cooperative work (CSCW), which is concerned with how people use technological systems to communicate, collaborate, and coordinate their activities. [34] Some felt that the concept of NUIs needed to be reframed into a model that could support these interactions. They describe Social NUIs as interfaces that "facilitate new forms of social interaction, participation and collaboration – how we communicate with each other, play together, learn together, and collaboratively work together through these technologies." [35]

Social NUIs place the focus on the relational aspects rather than the mechanics of interfacing devices. For this reason, it is an approach that arguably places greater focus on meaning and values because it encourages designers to:

> "...extend the broader set of analytical concerns around NUI technologies to consider the meaning and values of these technologies as they are enacted in context..." [36]

Given that most large interactive media displays are deployed in a public context, this study contends that the Social NUIs framework may be well-suited for this type of platform. To illustrate the forms Social NUIs could take in relation to dynamic digital displays, the following looks at four digital artworks that relied on custom-made interfaces specifically designed to engage users to experience the installations together as interactants *or* audience members.

Field Study: Four Interactive Art Installations

For a number of years and until recently, many of the HCI practitioners developing applications to interact with digital public displays used small, ubiquitous, portable devices such as cell phones or smartphones as their interface of choice. Although this trend was largely spearheaded by engineers, many artists followed suit by using this interaction strategy to conceive their own digital art installation. Figure 1, for instance, shows Yan Breuleux's *Tempêtes*, a media façade deployed in the Quartier des Spectacles that allowed people to post comments using text messaging.

Interface Size Matters: The *TRAME* Project

Our first case study offers a better example of how interaction with a media façade can afford greater shareability. Like the interactive video projection in Figure 1, *TRAME* sourced user input from people's personal portable devices, but its application called for more screen real estate.

TRAME is an interactive architectural lighting installation

Figure 1. *Tempêtes*, 2012, Yan Breuleux, video projection. ©2012MartineDoyon.

deployed in February 2011 on the media façade of a church located next to the downtown campus of Université du Québec à Montréal (UQAM). Born of an initiative instigated by NFB Interactive, the Rendez-vous du Cinéma Québécois and the Quartier des Spectacles Partnership, it was produced by Antoine Goudreault in collaboration with undergraduate students from l'*École des medias interactifs*.

In 2010, the Quartier des Spectacles hired the Montréal-based *VYV* firm to create detailed architectural mappings of their permanent media façades targeted by video projectors. VYV's signature *Photon* software has since been used by many artists to design media façades on the site. Given that each mapping carefully integrates the specific architectural elements of every building's façade, it becomes a tool that can be used to produce site-specific content that takes into account a media façade's peculiar shapes and textures.

TRAME was one of the first art projects to make use of VYV's custom-made software, which provided artists with a precise template of the intricate projection areas of UQAM's bell tower. Its video projections were made up of "episodes" each based on celebrated NFB animation films made by local artists in the past 75 year. Each episode paid homage to a key figure in the history of film animation.

In 2010-2011, UQAM students spent over seven months designing an application that could run on an iPod Touch, any smart phone, or an electronic tablet of variable size. During the deployment, anyone with a personal mobile device could download this application from the *TRAME* website to interact with an episode projected on the bell tower while it was being rendered live. Through simple touch screen commands, people could affect the music, and the speed or designs of dynamic visual motifs in real time.

Although the size of the input interface depended on whether people used their smart phone or a tablet, it would significantly change how people interacted. While smart phone screen size tends to encourage social cocooning, the increased visibility afforded by the oversized screen real estate of tablets made it possible for more than one person to watch a touch-based interaction. By including observers in the input process, here, interface size created conditions for socializing and thus for being involved in interactions.
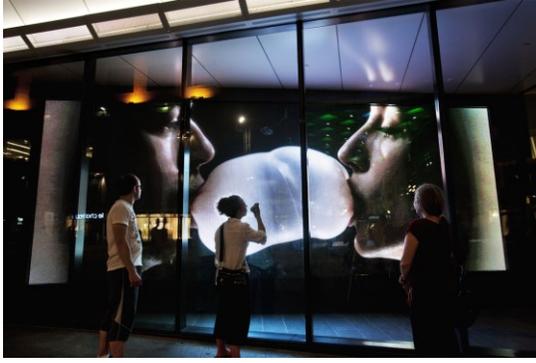
Figure 2. *By Means of a Sigh*, 2012, Jean Dubois and Chloé Lefebvre, interactive video art installation. ©2012MartineDoyon.

Rewarding Group Interaction *By Means of a Sigh*

Another interactive display-based artwork that relied on the use of personal mobile devices for input is Jean Dubois and Chloé Lefebvre's *By Means of a Sigh*. Featured in the context of the first edition of the Quartier des Spectacles's *Digital Pathway* urban interventions in Spring 2012, this interactive video was showcased on an oversized digital display located outside the Place des Arts building on Ste-Catherine Street, near Jeanne-Mance. This was one of the rare *Digital Pathway* deployments designed for an actual LED screen rather than for a video projection on a façade.

Dubois has often used an anemometer to design interactions around his art installations. These devices measure the force emitted by wind or air pressure to generate data. In Dubois's *Brainstorm*, for instance, when someone blows into the anemometer, the words projected on the screen begin to move faster and away from one another, creating the illusion that one's breathing can disperse them.

By Means of a Sigh similarly uses breathing as the input signal that triggers interactivity. Filmed and edited prior to deployment, this artwork simply consists of a video loop of a lateral view of a woman and a man facing each other as they each blow bubble gum. As the size of their bubble increases, their thinning walls touch and eventually burst.

Interactants can help blow the bubbles by calling a telephone number that connects them to the screen. Figure 2 shows how they can then gather around the screen and exhale into their mobile phone to move the video projection forward at a speed consistent with the intensity of their breathing. If no one blows air into their mobile phone, the playback slows down or almost stalls, creating the impression that the balloon is deflating. If many people blow intensely and steadily, the balloon inflates fast until it bursts, causing the video to loop back to the beginning again.

Practically, this means that when people work together, they can synergetically influence the outcome. Although the input interface is small in that it is typically the size of a mobile phone, the application has been fine-tuned so that when the number of people who blow increases, the interaction appears more effective, and thus visually rewarding.

The artists's stated intention was to tie the intimacy of embodied experience to the art installation [37]:

"Being able to use one's breath to modify a big image, much larger in scale than one's own body, is a sensory experience that can give people a feeling of personal empowerment. We were concerned with finding ways of making interactive works that include interactants' bodies as part of the art piece because when we interact with an artwork, we become a part of it. Interactive public art is a tool that can activate public space and create conditions that connect people to it and each other".

Although here, the art seems to be more about a process than an object, the physical and conceptual design of the interface determines the experience and value of the interactions. In this sense, the artwork attends to similar goals as Social NUIs by refocusing interactions on collaboration, play and meaning: it takes a village to burst these bubbles.

Interfacing Around a Campfire for *Bla Bla*

A few streets away, in front of a media façade deployed outside the Saint-Laurent subway station, an input interface that rekindled the age-old campfire metaphor offers yet a third perspective on how new media artists have been anticipating Social NUIs. Custom-designed for a public space installation that was co-produced by the National Film Board of Canada and the Quartier des Spectacles, the luminous podium seen in Figure 3 was the interactive portal of entry into the world of Vincent Morisset's *Bla Bla*.

Originally only available online, this interactive hand-drawn animation film was transformed into an interactive human-scale media façade on the occasion of the *Digital Pathway* in spring 2012. As was the case with the previous examples of practice, crossmodal interaction was triggered by touch-based input. Here, however, personal portable devices were replaced by a simple trackpad mounted on top of the stationary luminous plinth seen in Figure 3.

The input interface functioned much like the standard trackpads found on most laptop computers today. Indeed, hidden beneath the clean modernist lines and illuminated surfaces of the projecting base was a MACBOOK PRO™ connected to the fiber-optic cable infrastructure that leads

Figure 3. *Bla Bla*, 2012, Vincent Morisset, interactive animated video projection. ©2012MartineDoyon.

Figure 4. *Twenty-One Swings*, 2012, Daily Tous Les Jours. ©2012MartineDoyon.

Figure 5. *Twenty-One Obstacles* powered by *21 Swings,* 2012, Daily Tous Les Jours. ©2012MartineDoyon.

to the Quartier des Spectacles's master control-room. This economic lo-fi setup was, in effect, all that was needed to run *Bla Bla*'s entire interactive program every day from 9 pm to 2 am for the full eighteen nights of the deployment.

Although the basic interaction script consisted of interventions upon the animated images projected on the media façade, it is noteworthy that the device used to achieve this also responded to user input: the luminous intensity and color schemes of the plinth varied and flickered in response to how users touched the trackpad. As a result, *Bla Bla* highlights two interactive objects: the video projection and a site-specifically designed new media urban furniture.

Further, three form factors of this artifact evoke a campfire scene. First, the fact that the luminous plinth is fixed means that users must go to it, rather than freely move around as one would when using a mobile phone to interact. Second, its shape and size, not only enable, but also invite people to gather around it. Third, its luminosity is an entry point since it captures attention and draws us in. [38]

This leads us to say that *Bla Bla*'s input interface creates favorable conditions for people to socially interact and possibly eventually cooperate as well. As a kind of electronic campfire, it has much in common with Social NUIs.

Twenty-One Obstacles Set in Motion by *21 Swings*

Using accent lighting to single out the input interface of a display-based installation was a design strategy also used in the *21 Swings* luminous seats seen in Figures 4 and 5. Conceived by two Montréal-based interaction designers, Daily Tous les Jours's Mouna Andraos and Melissa Mongiat, this project is arguably one of the Quartier des Spectacles's most popular deployments. Located in front of the Place-des-Arts subway station public transportation hub, the swings were often used by people waiting for the bus.

Each swing was programmed to emit its own distinctive note. Whenever more than one swing was being used, different notes would be generated to create layers of sound. As a result, unique musical compositions would be produced each time there were multiple users. Further, if the vertical coordinates of at least two of the swings perfectly

synchronized, a special tune would play over the musical composition to reward interactants for swinging together.

When the *21 Swings* were deployed during the *Digital Pathway* in 2012, the designers connected them to the monumental *21 Obstacles* media façade in order to provide more possibilities for human-computer interaction: swing motion would then generate both audio output (music) and visual output (moving objects on the façade). Much like with a pinball machine, the colorful, geometric obstacles could be seen to chaotically collide into one other on the monumental media façade of UQAM's President-Kennedy building when graphics were powered by people's swinging. At times harmonious and at times cacophonic, *21 Swings* was a musical instrument that provoked and proposed new forms of social intercourse in public space.

Interactants seldom talked, but they did collaboratively make music together. Once, we observed a homeless man swinging next to young people; he was enjoying himself so much that he began to enthusiastically improvise his own melody over the musical notes played by the swings. He sang completely out-of-tune with the melody played by the installation. People lining up for the bus seemed bemused, but there was a sense of civic life, of people sharing a space and a moment that was just about being there and being part of something together. Something that was what it was. If interactive public space technology could enable more playful and respectful public interaction, might we see changes in how people relate to one another socially? Might the relational qualities of these works even play a role in meaningful social change beyond this public space?

Towards a Social Affordances Framework

These four examples of practice trace the evolution of some of the interfacing devices that supported interaction with artistic architectural-scale digital public display installations deployed within the perimeter of the Quartier des Spectacles from 2011 to 2012. In doing so, it highlights the idea that interactive installations deployed in outdoor settings might call for new frameworks that rethink interface design in terms of the peculiar context of public space.

On the face of it, the Social NUI framework seems to be addressing this challenge, but in fact, it is not specific to public space. Researchers have applied it to many domains that have been indoors or outdoors, private or public, and across domestic, leisure or work environments. Indeed, it was first developed around scenarios where technology was used to interact around the dining table at home; in surgical settings that required sterile practices; in relation to MOOCs and educational purposes; in family gaming events designed around brain-computer interactions; and to support cooperation and socializing in the workplace. [39]

There are other conceptual frameworks that – much like the Social NUI approach – could be applied to interaction in public space or with large display-based systems. However, none of them are specific to the former *and* the latter. For instance, Greenberg's *proxemics interaction* and Vogel and Balakrishnan's *spatial interaction* framework for ambient displays are display specific, but they are mainly applicable to spatial engineering in the context of a lab setting. [40] In the past, we published two frameworks that attempt to bridge the challenges of designing interactions for public space with those of designing for display-based systems, but neither placed social concerns at its core. [41]

Based on our field findings in the Quartier des Spectacles, it seems clear that the social dimension of public space should be a fundamental principle in any framework that aims to inform interface design for interactive public displays. While it appears that our study focuses on ergonomic design factors such as the screen real estate size of an interface, its location within an installation, its ability to entice and accommodate as many users as possible, and how this interface rewards co-locatedness and cooperation, it is, in fact, human factors – such as the public context of these interfaces and the relationship between people that results from this – that structure these physical affordances.

As far back as 2003, a study by Brignull and Rogers proposed a *public interaction flow model* and two concepts that have become foundational to our research on displays, namely *public interaction* and *social affordances*. [42]

"For public interaction to become a more acceptable mode of social activity requires the purpose behind it and how it is manifested around and at the display to have strong physical and social affordances, that people can easily and unambiguously pick up on." [43]

While Brignull and Rogers set out to achieve this by focusing on ways of reducing social embarrassment, raising awareness, and encouraging people to engage with displays in semi-private setting such as parties and intimate gatherings, our research embraces a social perspective that focuses its lens on relational aspects in public space. [44] In this sense, it straddles their model, the Social NUI approach, and prior work referenced above. What this study found is that interactive public installations by electronic artists often intuitively anticipate, and even paramount, social interface design thinking. For this reason, we believe that they might be regarded as best-practice examples in this area of study, suggesting that still today, blending art and science may provide more fertile grounds for research.

Conclusion

Using a multi-sited design approach, this qualitative field study investigated locations, events, artifacts, and stakeholders as distinct sites of representation to produce design knowledge in relation to interactive digital public displays. By presenting examples of practice, we aimed to show that ergonomic form factors can serve as entry points and social affordances that invite encounters and collaborations around an input interface. We also highlighted how new media artists use touch-based and gesture-based input, as well as crossmodal interaction to bring to bear the relationship between the digital and the material, the intangible and the tangible, the invisible and the visible world.

Like Social NUI advocates, we believe that by developing interfaces from a relational perspective that takes into account collaboration, meaning, value, and context, other ways can be found to design interactive digital public displays that might foster more rewarding forms of civic interactions, and possibly propose unprecedented manners of public interaction – itself a concept that, with smart cities on the radar, will likely gain traction in the years to come.

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