Proceedings of the 2nd Media Architecture Biennale Conference: World Cities

2014, Aarhus, Denmark
MAB14

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Sponsor: Aarhus University & The Media Architecture Institute

The Association for Computing Machinery
2 Penn Plaza, Suite 701
New York New York 10121-0701

ACM ISBN: 978-1-4503-3302-3

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DIY Media Architecture: Open and Participatory Approaches to Community Engagement

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ABSTRACT
Media architecture's combination of the digital and the physical can trigger, enhance, and amplify urban experiences. In this paper, we examine how to bring about and foster more open and participatory approaches to engage communities through media architecture by identifying novel ways to put some of the creative process into the hands of laypeople. We review technical, spatial, and social aspects of DIY phenomena with a view to better understand maker cultures, communities, and practices. We synthesise our findings and ask if and how media architects as a community of practice can encourage the 'open-sourcing' of information and tools allowing laypeople to not only participate but become active instigators of change in their own right. We argue that enabling true DIY practices in media architecture may increase citizen control. Seeking design strategies that foster DIY approaches, we propose five areas for further work and investigation. The paper begs many questions indicating ample room for further research into DIY Media Architecture.

Categories and Subject Descriptors
Human-centered computing~Interaction design theory, concepts and paradigms; Applied computing~Architecture (buildings); Applied computing~Media arts

Keywords
Media architecture; do it yourself; DIY; do it with others; DIWO; maker culture; participation; engagement; citizen control

1. INTRODUCTION
The discipline of Media Architecture is developing and growing as designers, architects, and planners realise the practice and promise that the combination of digital media and architecture can provide to enhance the experience of the built environment. Not only do the professionals in these disciplines need to consider how to incorporate the use of technology into the development of their profession, but they need to understand how technology can be used to improve how people engage with the built environment.

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ACM 978-1-4503-3302-3/14/11…$15.00
http://dx.doi.org/10.1145/2682884.2682893

According to Brynskov et al. [6: p. 1-2], *"Media Architecture is an overarching concept that covers the design of physical spaces at architectural scale incorporating materials with dynamic properties that allow for dynamic, reactive or interactive behavior. These materials are often digital, but not always, and they allow architects and (interaction) designers to create spatial contexts for situations using a variety of modalities."* Media façades are a typical example of media architecture, i.e., building surfaces that can display purposeful information using, e.g., light or projected animations to express changing moods of the occupants of a building. In this paper, we explore the coming together of the three main elements in the creative process of developing Media Architecture: the tangible platforms (façades and other physical material); digital media (smart phone, screen applications, etc.), and; design approaches. In doing so, we examine how to bring about and foster more open and participatory approaches to engage communities, and which part of the creative process depends on the craft and technical skill of experts. We are interested in identifying novel ways to put some of the creative process into the hands of laypeople, and in investigating the impact this may have on community engagement and citizen control.

This paper first explores DIY(do it yourself) and DIWO (do it with others) phenomena by looking closer at three categories of approaches and practices: DIY in *technical* domains (section 2), *spatial* domains (3), and *social* domains (4). We review and analyse each area to then synthesise our findings to propose a variation of Media Architecture that we call DIY Media Architecture. We examine some of the commonalities that may bring these related DIY fields together and what motivates the DIY cultures, communities, and practices. The aim of this paper is to animate and contribute towards a wider discourse. We ask if and how media architects as a community of practice should encourage and foster to 'open-source' our tools and approaches in order for laypeople to not only participate but become active instigators of change in their own right.

2. TECHNICAL DIY: MAKER CULTURE
In his book "Making is Connecting," Gauntlett [19] discusses the shift from Web 1.0 to 2.0 as becoming a "communal allotment" where the ability to share information, ideas, and creations became a reality encouraging participation and collaboration. *"Rather than just seeing the internet as a broadcast channel, which brings an audience to a website (the '1.0' model), Web 2.0 invites users in to play. Sites such as YouTube, eBay, Facebook… are clearly better the more people are using and contributing to them"* (19: p. 7). The ability to connect and communicate through Web 2.0 [27] with people all over the world has assisted not only in the organisation and establishment of networks supporting real-world activities [19], but also what Gordon and de Souza e Silva call "net localities" [21].

As interests in digital activities surge, there has also been resurgence in the practice of craft culture [16]. The value of craft lies in the skills required to create handmade and unique artefacts as opposed to the skills of the expert elite [19]. The notion of DIY arose out of the open-sourcing of craft so that the skills and knowledge required to create, was accessible to anyone and not a matter of affordability that arose from "American optimism, and communicated in a cheerful and unpretentious way" [19: p. 49]. We note the difference between the craft world and art world and acknowledge that those in the pursuit of making may primarily seek neither fame nor fortune, but the enjoyment of the experience of making and creating and sharing artefacts.

Opting for a DIY approach is sometimes based on an implicit decision to oppose consumerism and instead promote individual creation that often goes beyond the material or tangible artefact, as it spills over into the crafting of experiences as well. With the combination of Web 2.0 networking and an increasing interest in making things yourself, the DIY culture has gone beyond the craft world to encompass the development and sharing of technological knowledge, what is referred to as the maker and hacker cultures [1].

The maker culture promotes informal environments supporting peer to peer learning and learning through making, regarding mechanical and technology driven interests such as 3D printing, computer numerically controlled (CNC) machining, soldering, tinkering, robotics, metal and woodwork. Hackerspaces and FabLabs are examples of "maker spaces" which are found across the globe, with an increasing prevalence in public libraries [4]. Out of the Center of Bits and Atoms at MIT, the FabLab initiative arose as a workshop aimed at providing self-replicating tools to communities. Currently there are 89 FabLabs in 23 countries according to fabfoundation.org. Hackerspaces are community operated informal learning spaces that promote collaboration [4, 7]. Hackerspaces typically house digital fabrication machinery such as 3D printers and CNC routers in addition to soldering and woodworking tools. Mota [30] describes the creation of Hackerspaces as a direct response to the needs and interests of the community who participate within them. The success of digital fabrication is attributed to the DIY movement, which is based on self-improvement through the development of new skills and knowledge: *"Access to tools capable of turning digital designs into physical objects, coupled with the ease with which digital files can and are being modified and circulated, is bringing a third dimension to the practices of sharing, mashup and remix, and giving everyone the opportunity to not only reinvent and shape the world of bits, but also the world of atoms. The next decade will tell if indeed… we are makers."* [30: p. 286]. The affordances of digital networks combined with a resurgent interest in craft culture and DIY movements reflect the power of personal creativity and making throughout communities across the world [7].

The hacker culture comes from a community that has a passion for computers, their development, and a strong belief that information should be free, specifically Free Open Sourced Software [29] and is based on Castells' ideals of *"individual freedom, independent thinking, and of sharing and co-operation"* [cited in 34: p. 24].

Acknowledging the importance of the amateurs or lovers, in the evolution of technology, Paulos supports DIY cultures and calls on technologists and engineers to shift their thinking towards more participatory collaborations and innovations. He encourages ubiquitous computing researchers to enable participation from the everyday citizen to address global issues such as climate change, famine, and poverty [32, 33].

Similar to the shift to Web 2.0 that allows users to create digital content, tinkering platforms have been developed assisting more people to participate in hacking and making. The development of primarily open-sourced and off-the-shelf hacker tools have made it possible for anyone to combine microcontrollers with sensors to build experimental computing for individual purposes [11]. Such tools streamline the process so that users do not need extensive knowledge in computer science, programming or electronics in order to create interactive environments, citizen science sensor networks, robots, or drones themselves. Such platforms and tools include: Arduino, Wiring, Raspberry Pi, MakeyMakey, Ninja Blocks, Beagleboard, SmartCitizen.me, Phidgets, Teensy, and many others.

3. SPATIAL DIY: PLACEMAKING

The crafting of place, DIY placemaking is a concept we describe that encompasses a range of urban interventions for the purpose of appropriating public spaces to assist in civic engagement, the communication of often political messages, or to simply improve the quality and experience of a place. Examples of DIY and DIWO placemaking practices include guerrilla gardening and seed bombing, guerrilla knitting / yarn bombing, parkour and graffiti, which we will now discuss in turn.

The aim of guerrilla gardening is to turn abandoned city spaces into beautiful gardens. Guerrilla gardeners are armed with shovels, hoes, plants, and watering cans all used to plant flowers, vegetables and herbs in unused spaces [20]. Key characteristics of guerrilla gardeners are the use of quick surprise attacks on neglected and weed encroached parts of the neighbourhood [20]. Although there is a parallel drawn between the guerrilla soldiers and gardening warriors, guerrilla gardening movements are seen to be peaceful movements which provide colourful, sometimes edible responses to overgrown and abandoned areas within the urban spaces we live in.

"Guerrilla knitting is defined as a range of practices that employ 'vigorous' or 'militant' knitting activity in mass demonstrations, in urban interventions, and for political causes, using knitting in controversial, unusual, or challenging ways" [31: p. 143]. The juxtaposition of the tangible, tactile, and colourful characteristics of knitting in an urban setting such as around a park bench or bike rack (Fig. 1), makes the presence of knitting felt and known to the city dweller.

Figure 1. Yarn bombed bike rack. [Eli Carrico, Flickr CC]

Corbett and Housley wrote *"The Craftivist Collective Guide to Craftivism"* [9] which defines craftivism as the promotion of

human rights issues through the combination of activism and craft.

Crafts such as cross-stitching are used as tools to spread the message while activism is the core goal of craftivist projects [8, 9]. Crafted or handmade objects placed in the built environment reflect the efforts of the people who made them and therefore increase the engagement and respect that the general public have for such objects compared to mass produced and off-the-shelf objects [8, 9]. The political choice to not buy but to create something for yourself, is how crafts such as knitting, weaving, gardening, cooking, and sewing have taken on activist characteristics [19].

The craftivist collective relies on a central website (craftivist-collective.com) to organise projects and people across the world. The website collects images and information about the projects in order to display the impact of their collective efforts [8, 9]. The collective also uses a range of social media to promote craftivism to a wide range of people [8, 9].

Parkour is an urban play form where the player (traceur) relies on calisthenics and gymnastics to traverse through the built environment [35]. It is a creative reinterpretation and a sensory experience of space. The perception and understanding of the material form and feeling of the city is heightened as the traceur moves over and between buildings, bridges, walls, etc. The playful activity of parkour is challenged by the boundaries created by the built environment, and it is the overcoming of these obstacles that generates feelings of empowerment and ownership of physical space. *"Parkour's emotional connection with place comes as a result of both the sensually intimate nature of Parkour activity and the use of a conceptual frame highly integrated with the urban context."* [35: p. 9]. The urban experience that parkour offers, although not necessarily illegal, does illicit conflict with the normative regulations, ownership boundaries, private space, etc. Parkour exemplifies the DIY appropriation of public space for the crafted physical experience of the city for purposes of fitness and exercise.

Figure 2. Graffiti. [Jungla, Flickr CC]

Graffiti is often viewed as an act of vandalism and therefore considered against the law in many cities. Iveson argues that, *"graffiti writers demonstrate by their actions that they do have a right which is denied them by law – the right to use the surfaces of the city as a medium of public expression. The 'right to the city' is a cry, a demand and a lived experience in the face of exclusion."* [24: p. 436]. Research into graffiti found that it is a complex form of expression where individuals purposefully affect urban environments through their art, where the right to public vs. private space becomes contentious. Graffiti blurs the edges between property and behaviour codes, and is seen to construct "a sense of place where sociality is in question" [12: p. 39]. Graffiti writers usually do not wait for permission or seek formal approval, they do it for themselves, and therefore we consider them to be part of DIY place-makers.

Graffiti writers tend to consider their work as a way to bring vibrancy and colour to dull urban spaces [38] that are often forgotten (Fig. 2). They use their skills and artform as a means to appropriate public space from corporate business or entities. *"Graffiti writing was a protest at this 'corporatisation' and an attempt to engage with the urban landscape in a way that represent more than private commercialism"* [37: p. 78]. Rowe and Hutton [37] conclude that graffiti is a connection between the writer and the urban landscape. It is an artform that is filled with cultural meaning and highly appreciated by its community. The creation of place through graffiti has been questioned and studied by Dovey et al. [12] who conclude, *"While it is applied to and erased from urban surfaces, it is more than a veneer applied to the urban fabric because of the deeper social identifications it both facilitates and expresses. The graffiti, like the sense of place, is deeply ingrained without being deeply-rooted as essence; it is immanent rather than transcendent,"* [12: p. 38].

4. SOCIAL DIY: URBAN CITIZENSHIP

Having introduced notions and examples of DIY and DIWO movements in both technical and spatial domains, we now briefly discuss two examples of DIY in the social domain – DIY citizenship and DIY urbanism.

In an attempt to link and understand the individual actions, the blurring of borders, the overlapping interests and motivations, we believe there are two key concepts that provide a bigger picture description of what these DIY phenomena mean in a social and urban context. First, Ratto and Boler propose, *"'DIY citizenship,' [as] a term intended to highlight the diversity of ways citizenship is enacted and performed,"* [34: p. 4]. This concept focuses on digitally mediated practices where people rely on social media and Web 2.0 for the sharing of content, ideas, and information to create global communities with interests ranging from political action, craft, design, science, and technology. This open sourcing of information can also be viewed as political as it questions the rights of public vs. private property and challenges boundaries of authority [34]. DIY citizenship asks how people and communities are using creative ways to shape, alter, and rebuild their environments to be how they want them to be and not how they must be. DIY citizenship goes beyond standard political actions such as voting but is about participation, diversification, and social interventions.

Second, Iveson [25] proposes DIY urbanism as a link between the small actions and appropriations of urban space such as the ones mentioned previously (Guerrilla Gardening, Parkour and Graffiti) into a larger understanding or vision that affects the socio-cultural experience of cities. What links these small actions is that the inhabitants of the city imagine and create a tailored city within the city by occupying or transforming urban spaces through the injection of new meanings and functions [25]. These inhabitants are motivated by their own purposes and often operate at the fringes or even outside existing policies and laws, they take action upon their rights as inhabitants of the city.

5. TOWARDS CITIZEN CONTROL

Dade-Robertson [11] makes the analogy between Graphical User Interfaces (GUIs) of personal computers with how he defines *Architectural User Interfaces* (AUIs) as buildings that

mediate between computational information and people. In so doing, he connects the disciplines of architecture and human-computer interaction (HCI), arguing that not only does media and technology affect how people experience urban environments, architecture similarly has an affect on the development of computer technologies [11]. He believes that through the rise of ubiquitous computing the value of physical environments has been re-acknowledged increasing the opportunities for architectural influence on the evolution of HCI practices. The call for architectural knowledge and input into HCI research is reinforced by Fischer et al. [13] who claim that the architecture provides spatial understandings that can assist in the development of urban HCI systems. They argue that through an architectural approach public displays can be refocused *"for a city beyond information and utility"* [13: p. 39].

As the UK graffiti artist Banksy states, *"twisted little people … go out everyday and deface this great city. Leaving their idiotic little scribblings, invading communities and making people feel dirty and used. They just take, take, take and they don't put anything back. They're mean and selfish and they make the world an ugly place to be. We call them advertising agencies and town planners"* (cited in 41: p. 78). As some like Banksy may think that media architecture – if not considered and appropriated properly – runs the risk of polluting the city with more advertising and media 'junk.'

We would like to ask how can media and architecture be combined to help people take control, appropriate place, and create communities. Acknowledging that media architecture is an emerging field that combines people, place, and technology in a similar way to related hybrid practices such as urban informatics [15], it has an effect on the way the city is experienced and how people come together. This paper seeks to question what role will it have in facilitating communication and the interaction of city inhabitants?

To explore this question we have identified existing examples of the ways in which media and architecture are currently combined to consider how they are communicating and interacting with the cities in which they exist. Based on works by Verhoeff [42], Arnstein [2] and Foth et al. [14], we revise Fritsch and Brynskov's scale of interactivity [18] by presenting attributes as independent qualities rather than a strict hierarchy. We further extend their work by proposing additional characteristics of media architecture, the notions of *performative* and *citizen controllable*. The attributes are not intended to be linear or progressive; they can be understood as qualities that can occur in parallel or alongside to one another.

☐Static ☐Dynamic ☐Reactive ☐Interactive ☐Participatory ☐ Communicative ☐***Performative*** ☐***Controllable***

We employ these attributes of interactivity to assess the quality of select examples informing how they are used, to ultimately propose a variant approach to media architecture, that is, DIY Media Architecture. What can be learnt from these examples to identify opportunities for further development and ultimately push the boundaries to promote a higher level of community engagement through media architecture, one that is based on the appropriation of urban spaces by city dwellers?

The following sections examine a range of media architecture examples from across the world that range from large-scale buildings to small-scale installations; media façades, media structures, digital urban screens, media projections, and tangible media architecture interfaces.

5.1 Media Façades

The Star Place, Kaohsiung, Taiwan (Fig. 3), designed by UNStudio in 2008 is an example of a dynamic media façade. As described by Haeusler et al. [22] the Star Place façade is designed to reflect the luxury shopping experience offered by the building. The media façade is animated by coloured lights, *"that respond to the building's setting and purpose"* [22: p. 27]. Based on the interactivity scale this piece of media architecture is an example of a dynamic façade.

☐Static ☑**Dynamic** ☐Reactive ☐Interactive ☐Participatory ☐Communicative ☐Performative ☐Controllable

Figure 3. Star Place, Taiwan. [Mastahanky, Flickr CC]

The façade provides little opportunity for individuals to interact directly with it. The façade is used to attract the attention of people and to promote the status of the building and those that occupy it. The combination of media and architecture in the Star Place building is an example of a top-down approach where the property owners, architects, and designers direct the media onto the street and urban environment providing no possibilities for people to direct their own media or information onto the façade. The media façade was part of the initial design and integrated into the building's form and structure.

The Ars Electronica Center in Linz, Austria (Fig. 4), is an example of media architecture that reflects the meaning of the building itself through its dynamic and interactive façade.

Figure 4. Ars Electronica Center. [Rubra, Flickr CC]

As stated on their website, *"The Ars Electronica Center is the architectural expression of what Ars Electronica is all about: a place of inquiry and discovery, experimentation and exploration, a place that has taken the world of tomorrow as its stage, and that assembles and presents influences from many different ways of thinking and of seeing things."* In keeping with the Ars Electronica festival, which combines art, technology and society, the building provides spaces for conferences, research, exhibitions, workshops, research and development [22]. The media façade consists of a glass skin with 40,000 LEDs that is

made available to designers, artists, and researchers. In some instances, it has been used to explore the interaction of people through mobile phones. This building has been designed and created to go beyond dynamic and encourage interaction and participation from the public.

☐Static ☑**Dynamic** ☑**Reactive** ☑**Interactive** ☑**Participatory** ☐Communicative ☐Performative ☐Controllable

In one example of its use, participants from the general public – via a digital music player – were able to plug into the building façade where it then reacted creating a lightshow performance based on the music the individual chose to play. Allowing users to plug into the façade and select music enables them to control the content of the façade. The media façade of this building was also an integrated part of the building design that informed its form, structure, and materiality.

5.2 Media Structures

D-Tower is an interactive public artwork created by architect Lars Spruybroek from NOX-architekten and artist Q.S Serafijn who were commissioned by the City of Doetinchem, The Netherlands in 1999 to 2004 (Fig. 5). The purpose of D-Tower is to record feelings of happiness, fear, love, and hate expressed by the city inhabitants through a web based questionnaire. The website collects answers from participants and calculates the overall mood of the city. The D-tower lights up at night to show the dominant feeling based on the colour displayed.

Figure 5. D-Tower. [Hugo-Photography, Flickr CC]

The D-Tower is dynamic by reacting to the information provided by the submissions collected on the website. The tower does not provide for direct interaction from people on the street but does call for a larger participation via the website which is then communicated back to the community.

☐Static ☑**Dynamic** ☑**Reactive** ☐Interactive ☑**Participatory** ☑**Communicative** ☐Performative ☐Controllable

The D-Tower was designed and constructed to specifically include media and technology in its architecture for the purpose of encouraging participation from the city community.

5.3 Urban Screens

Discussions in Space (DIS) is a situated engagement tool that promotes public participation through a digital public screen [40]. Users can send a message via SMS, Twitter, or a web based platform to the screen. The purpose of DIS is to expose context specific questions about place to encourage everyday people to be involved in the discussion regarding local issues and have their say. Discussions in Space has been used at Federation Square in Melbourne since 2011 (Fig. 6). It forms part of the regular programming of their iconic big screen and engages with visitors during events such as Oprah's visit, New Year's Eve, Cadel Evans' 2011 Tour de France victory parade, the Queen's Royal Visit, and Thoughts for Molly Meldrum.

DIS is dynamic, it is constantly changing depending on the users and their interaction with it. It reacts to the amount of input provided and encourages interaction and participation by displaying the comments that are sent to it. DIS promotes communication by exposing a question that is important to the context in which it is located.

☐Static ☑**Dynamic** ☑**Reactive** ☑**Interactive** ☑**Participatory** ☑**Communicative** ☐Performative ☐Controllable

Figure 6. Discussions in Space, FedSquare Melbourne.

Discussions in Space is an application that was designed for use on large media screens which have typically been retrofitted onto building façades. This is the first example we discuss where the design of the media and the architecture were not part of the original architectural design. Discussions in Space can be run on any digital screen, therefore, there is no direct correlation between its design and the design of the architecture or urban space in which it is applied and used.

Figure 7. CubIT running on The Cube, Brisbane.

The Cube is part of Queensland University of Technology's Science and Engineering Centre (Fig. 7). It is currently one of the largest digital and interactive learning and research spaces in the world promoting explorative and participatory experiences to the university community and the public. It is composed of more than 40 multi-touch screens and 14 high definition projectors (thecube.qut.edu.au). The content that is created for display on The Cube is mainly based on STEM (science, technology, engineering and maths) research and artistic

practice. The Cube hosts a range of hands-on workshops for schools, provides residencies for artists and researchers, and a series of public events focused on engaging with the STEM disciplines of the university.

The purpose of The Cube is to engage with the learning of the STEM disciplines through an interactive and technologically based environment. The content on The Cube is designed to be highly dynamic and reactive to the user interaction and participation. Primarily, The Cube displays information or content, however, through one of the purpose-built applications called CubIT, registered users are able to display digital files on the interactive screens [36]. Through its residencies and workshops, people can create content to be displayed on The Cube, however, it is not something that anyone can do at any time, therefore it is participatory only to a degree.

☐Static ☑**Dynamic** ☑**Reactive** ☑**Interactive** ☑**Participatory** ☑**Communicative** ☐Performative ☐Controllable

The Cube is situated within a designed for purpose part of the Science and Engineering Centre. The design and placement of The Cube is intentional for the purpose of direct interaction and engagement with students, staff, and the public.

5.4 Media Projections

The project **Night Lights** created by YesYesNo Interactive Projects in collaboration with The Church, Inside Out Productions, and Electric Canvas, focused on turning *"the Auckland Ferry Building into an interactive playground"* (yesyesno.com/night-lights). YesYesNo Interactive Projects is a media collective based in New York City who focus on creating interactive media and magical, creative, artistic, technological installations.

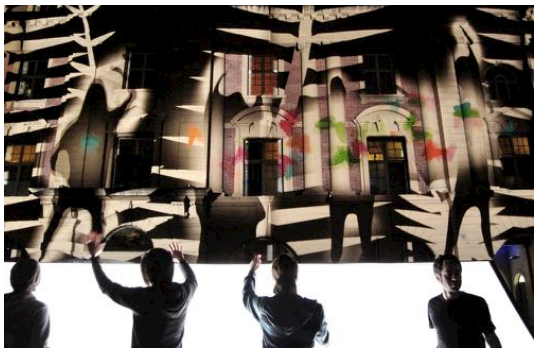

Figure 8. Night Lights. [yesyesno.com/night-lights]

The purpose of the installation was to go beyond projection onto the façade of a building by allowing participants to become performers through the amplification of their movement onto the building (Fig. 8). Phone, hand and body interaction were incorporated into the performance and amplification on the building (yesyesno.com/night-lights). This project sits highly on the interactivity scale as it allows users to become the creators of the content that is projected onto the building through their performance. Night Lights is dynamic, reactive, and interactive promoting participation and performance from its users. The media façade does not communicate any semantic information.

☐Static ☑**Dynamic** ☑**Reactive** ☑**Interactive** ☑**Participatory** ☐Communicative ☑**Performative** ☐Controllable

Night Lights is an installation designed to be projected onto the existing façade of a building. In this case the media is not related to the design of the building.

5.5 Tangible Media Architecture Interfaces

The Smart Citizen Sentiment Dashboard is described by Behrens et al. as a Media Architecture Interface (MAI), *"the synthesis of situated 'tangible user interfaces' (TUIs) connected to media facades in urban space,"* [3: p. 2]. The dashboard was connected to the existing media façade of the FIESP building in São Paulo, Brazil, during a three week media arts festival in September 2013 (Fig. 9). The dashboard was situated across the street from the building and next to the transport entrance that allowed users the distance to see the full façade of the building. The dashboard employed RFID technology so users can interact with it using their transport RFID tags to indicate their mood and respond to issues regarding the use of technology in the city such as environment, transport, safety, public space, and housing [3]. The response from the users was then translated onto the media façade through animations including mood indicating colours and icons, for all else to see. Each response was aggregated to the existing responses indicating *"an overall 'sentiment' of the city towards its urban challenges"* [3: p. 4].

Figure 9. Smart Citizen Sentiment Dashboard in São Paulo, Brasil. [N Valkanova, Flickr CC]

The Smart Citizen Sentiment Dashboard encourages users to participate in the communication of the sentiment of the city. The media façade becomes interactive through the dashboard. Without the use of the dashboard users do not have the ability to interact with or communicate through the façade.

☐Static ☑**Dynamic** ☑**Reactive** ☑**Interactive** ☑**Participatory** ☑**Communicative** ☐Performative ☐Controllable

The design of the tangible component of the Smart Citizen Sentiment Dashboard is in direct response to the engagement it intends to solicit from its users. The application that connects the dashboard with the building is retrofitted onto the existing media façade of the FIESP building. Previously, the façade did not allow interaction from users on the street.

The **SMSlingshot** is described by Fischer et al. as, *"a media façade system at the confluence of art, architecture, and technology design in the context of human computer interaction"* [13: p. 38]. The purpose of the SMSlingshot is to promote civic and social dialogue through a participatory approach. The SMSlingshot is a tangible device allowing users to type a text message that is 'shot' onto the media façade (Fig. 10). The process of shooting onto the screen is intended to *"evokes memories and feelings of childhood unruliness. This playful rebellion gives the slingshot a guerrilla-like quality, which fits with our overall vision of 'reclaiming the screens'"*

[13: p. 40]. The act of shooting is performed by the user creating a sense of control over the creation of content for the façade. Fischer et al. [13] argue that the ability to shoot across a long distance onto a large media façade heightens the user experience by bridging the gap between architectural and human scales.

Figure 10. SMSlingshot at the TodaysArt Festival, The Hague, The Netherlands, 2011. [Haags Uitburo, Flickr CC]

The SMSlingshot provides the creation of a dynamic and responsive media façade that promotes participation and performance from the situated public as indicated on the interactivity scale.

☐Static ☑**Dynamic** ☑**Reactive** ☑**Interactive** ☑**Participatory** ☑**Communicative** ☑**Performative** ☐Controllable

The SMSlingshot media façade system can be categorised as a Media Architecture Interface, as it, too, has been designed to act as the mediator between the participation of the city users and the media façade. This system can operate on either a digital screen or through projection, therefore, the design of the building is not in direct response to the media.

6. DIY MEDIA ARCHITECTURE

In this section, we first review examples of nascent DIY Media Architecture. What sets these examples apart from those examined in previous sections is that these were not developed as media arts projects or installations for a client, a festival, or dedicated media façade or screen, they are created from the bottom up. These examples are the result of a need to communicate to a large audience. The creators had big ideas and messages they wanted to share with the general public and found that the built environment provided the best medium to do so.

Second, we look at the building blocks of DIY Media Architecture and review a number of 'kits,' prototyping tools and platforms to enable others to use and reuse some of the resources that were originally being created for a specific Media Architecture project. Such tools and platforms not only enable a reuse and recycle approach to the artefacts and building blocks, but also a remix culture that encourages adoptions, adaptations, and appropriations in the spirit of open source and DIY.

Third, we tentatively and carefully propose a number of additional areas of investigation to help create some more robust design strategies to enable true DIY Media Architecture to flourish.

6.1 Examples

The following two examples involve projection onto the built environment. They can be described as guerrilla projection which is a tactic contributed by Corbin and Read in the guerrilla handbook, "Beautiful Trouble" [10]. Guerrilla projections are used by activists as a medium to broadcast and deliver a message. The benefits of this tactic are the temporary reach that projection provides, by allowing the message to be placed on the façade of a building or an area that is not physically accessible [10]. This tactic is generally risk free and low cost while also visually appealing by casting light on the "opposition." The projection can be mobile, malleable, and interactive in combination with online tools that supporters can tweet or SMS messages displayed in real time.

The **SMS Guerrilla Projector** (Fig. 11), created by Troika in London, 2005, is a homemade projection device allowing users to project SMS text messages in public spaces including streets, signs, onto people, and buildings (troika.uk.com/project/sms-guerilla-projector). Troika is the name for the art and design studio of three artists who work together: Cony Freyer, Eva Rucki, and Sebastien Noel. They are the authors of the book "Digital by Design." As artists and designers, their work takes a creative approach to the use of technology to explore its impact, raise questions, and experiment with its potential [17].

Figure 11a and b. Troika Projection and the Troika Projector [troika.uk.com/project/sms-guerilla-projector]

Mark Read created the **Bat Signal Project** (Fig. 13 & 14), as a part of the Occupy Wall Street Movement in 2011, which included large-scale guerrilla projections onto buildings in New York City [26]. The projection displayed the 99% image along with a series of quotes that were chanted by the tens of thousands of protestors walking across the Brooklyn Bridge with LED candles.

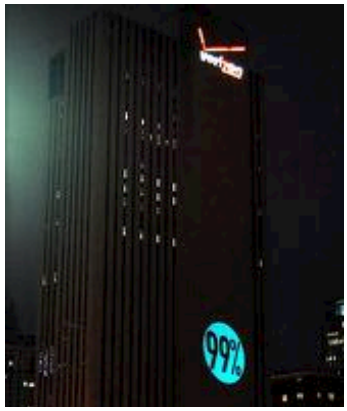

Figure 13. Bat Signal, NYC. [Joe Lustri, Flickr CC]

The power of guerrilla projection is described by Corbin and Read: *"Projections help us upend the power dynamic. The buildings of the powerful can feel so big and our voices and protest signs so small. But when a huge '99%' bat signal lights up the sky, or you see your own handwriting scrawled across a coporate HQ in real time, it begins to level the playing field. Small voices are writ large."* [10: p. 113].

The issue of scale is made clear by this statement where individuals often feel small in comparison to tall buildings that are representative of large organisations or corporations. By projecting onto a building façade, the size of the statement is in direct response to the size of the building and the size of the corporation. Although the activists may feel small in physical stature, the projection medium allows their voices to be largely visible to a greater portion of the audience and increasing the reach, size, and perhaps value of their message.

Figure 14. Guerrilla Projection, Occupy Wall St movement. Image Credit: Brennan Cavanaugh via Flickr CC

Understanding the basis for DIY and DIWO cultures is an important aspect to the development of DIY Media Architecture. Examples of DIY Media Architecture not only possess a ground up outcome, it is the process, the design, and development that entails a DIY approach and fundamentally seeks to provide a voice or communication means for the local community or the public at large.

Figure 15. 3D Print Canal House. [Andrew Sides, Flickr CC]

The **3D Print Canal House** (Fig. 15) is a form of DIY Media Architecture where 3D printing technology is being developed to print a canal house in Amsterdam as part of a collaborative research and building project connecting design, technology, science, and the community (3dprintcanalhouse.com).

The project intends to explore the benefits and challenges of 3D printing technology for the construction industry. One of the strengths of 3D printing is the ability to create customisable and detailed artefacts. The project aims to use sustainable materials to create low-impact housing solutions for any global location. The fundamental design, research and production of the 3D Print Canal House relies on the open sourcing of information, *"What makes the 3D Print Canal House special is that it is a project which is 'open' in every way: The initiators, designers and builders (DUS architects) are the client: the focus is on research, experimentation and development, instead of finishing a house"* (3dprintcanalhouse.com). Some of the components are made of translucent plastic and when experimented with different lighting options the building becomes an example of DIY Media Architecture.

6.2 Prototyping tools, kits, and platforms

Inspired by the success of the DIY, DIWO, and tinkering platforms that we briefly introduced above, such as Arduino, Raspberry Pi, and MakeyMakey, media architects have started to devise their own custom-made prototyping tools, kits, and platforms. Hoggenmüller and Wiethoff [23], for example, presented *LightSet* as a way to enable urban prototyping of interactive media façades. Their work extends and integrates the *LightBox* previously discussed by Wiethoff and Blöckner [43] as well as research by Korsgaard et al. [28] on the *Odenplan*.

Tools and platforms such as these, are essential to enable more sophisticated, advanced and complex creations, an upscaling of situated media architecture design interventions, better collaborations, as well as to avoid reinventing the wheel. However, one of the key self-acknowledged issues with many such tools and platforms remains the expert level technical knowledge and know-how required in order to master them for both laypeople and novice media architects trying to become productive and create impact.

Working on improving both accessibility as well as useability of prototyping tools, kits, and platforms is currently a significant endeavour in media architecture, as can be seen by the diversity of workshops held at this year's Media Architecture Biennale with not less than four of them focussing on issues related to themes of prototyping and open source:

- Tools, Services and Building Blocks for Creating Media Architecture;
- Prototyping Interactions with Media Façades;
- Open Source Media Architecture;
- Fingies Toolbox for Media Architecture.

We believe it is useful to review and reflect on the experience in other domains and disciplines in order to leapfrog our own undertakings.

6.3 Strategies

We finally seek to tentatively propose a number of areas for further investigation in order for us as a community of practice to eventually come up with more robust design strategies and recommendations. This section is meant to stimulate and continue a broader discussion not only of what it means and what it takes to enable DIY Media Architecture, but also what impact it may have – both good and bad.

Mostly used in the context of community consultation in urban planning, the highest level in Arnstein's Ladder of Citizen Participation is 'citizen control' or 'empowerment' [2]. Similar

taxonomies have been adopted by the *International Association for Public Participation* in their IAP2 Framework and Toolkit (iap2.org). We argue that enabling users, i.e., residents, citizens, people, of media architecture to not only 'use' – even in the most participatory manner – but also to become DIY designers and creators in their own right, may lead to citizen control. In order to foster design approaches and strategies that lead to citizen control, we propose five areas for further work and investigation. In our view, DIY Media Architecture requires:

1. Transdisciplinary teams with expertise that covers social, spatial and technical research and design domains;
2. Participatory approaches and methodologies – not just for the artefact at the end, but also the design process (e.g. Participatory Design, Participatory Action Research);
3. Open source repositories of code and documentation;
4. Creative commons licensing;
5. Design strategies that allow for future tinkering, expansions, appropriations, and remixes, and for those DIY and DIWO activities to be documented, too, in a similar fashion to Brand's famous work in architecture itself [5]. Brand [5] famously encouraged architects to embrace the fact that the designer's intent is not always identical with the way people use, perceive, or appropriate an artifact.

7. CONCLUSIONS

Learning from existing activist cultures and the DIY movements, the solution for media architecture in engaging with communities successfully will be in taking a meta-design approach. Designers in this field will have to use their expertise and professional knowledge to set up the opportunities and provide the tools for society to take control and combine media and architecture for their own purposes.

Schneider and Till argue that architects have the choice to be a spatial agent, *"one who effects change through the empowerment of others. Empowerment here stands for allowing others to 'take control' over their environment, for something that is participative without being opportunistic, for something that is pro-active instead of re-active"* [39: p. 99]. It is in this vein of pro-activity and open sourcing of information that we aspire for a higher level of application for media architecture, where the boundaries of HCI, interaction design, media, and architecture can be pushed and woven together to allow for DIY Media Architecture to continue to occur.

When considering how to promote DIY Media Architecture, we need to question how such interventions would be governed and how they would be designed? How can spaces and technologies be made available and open to the public so that they can create their own interventions? Do designers and property owners provide the framework and toolkits for DIY Media Architecture to be developed upon? What are novel components and platforms that are needed to create a DIY Media Architecture intervention?

One approach would be *plug & play*, as in the Ars Electronica Center, where a façade is ready for anyone to take control of the content by plugging in their smart device or computer. Another approach similar to the SMSlinghot, is to have a tangible device that acts as the mediator between the façade or projection and the public user. Could property owners and city councils allow façades and public spaces to be "checked out" like the process of borrowing books from a library?

We learn from the examples discussed in this paper that designing for interaction, appropriation, and communication, are critical aspects of DIY Media Architecture. The answers to the questions raised need to be considered from all parts of city makers including planning authorities, councils, architects, designers, property owners, developers, and city inhabitants. A successful urban environment is one that elicits participation from its users, highlighting the powerful combination of media and architecture to provide a voice for the people that will continue to attract interaction in their own right.

As far as we can ascertain, there has not been any research to differentiate between successful community engagement from integrated architectural designs of media architecture versus retrofitted media onto existing architecture. This is an area which needs further investigation to understand the effectiveness of design in the implementation of media architecture.

8. ACKNOWLEDGEMENTS

We thank the peer reviewers for their constructive feedback.

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The Empire State Building and the Roles of Low-Resolution Media Façades in a Data Society

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ABSTRACT

Media façades are playing an increasingly important role in media circulation and the experience of the city. The highly visible and data-reactive low-resolution displays of the CN Tower and the Empire State Building, for example, shape the texture, tempo, and legibility of the urban experience, an experience that is produced (and consumed) in a unique combination of on and offline activity. I evaluate the role that these buildings play as public data visualizations by examining the degree to which they are situated, informative, and functional, and by the way they balance and extend a combination of environment, content, and carrier that include on an offline spaces. Through historical research, and social media analysis, this paper focuses on the specific case of the Empire State Building and reports on the relationships between information, public space, and architecture that are sustained and supported by low-resolution, expressive architectural façades. Emerging from histories of weather beacons and illuminated architecture, I argue that these expressive surfaces increase the ambivalence and contingency of the experience of the city, enabling the formation of temporary publics through public data visualizations that combine elements of democratized urbanism, debate, emotion, control, and commerce. Furthermore, buildings with programmable low-resolution media façades are palpable substantiations of supermodernism, that is, of the irruption and imbrication of the "infoscape" and the cityscape, of information aesthetics in architecture. The paper also includes an evaluation and discussion of the potential for art and activism for low-resolution digital architectural displays through two research-creation projects: *In The Air, Tonight* (2014), a project created for the LED façade of the Ryerson Image Arts Centre in Toronto, and *E-TOWER* (2010), a project created for Toronto's CN Tower.

Contribution to the Media Architecture community: Case study of Empire State Building and investigation of low-resolution media façades as tools for commerce, critique, and civic development through social media and public data visualization.

Categories and Subject Descriptors

J.5 [Arts and Humanities]: Architecture.

General Terms

Design, Experimentation, Human Factors.

http://dx.doi.org/10.1145/2682884.2682885

Keywords

Media façades, architecture, social media, digital culture, information aesthetics.

1. INTRODUCTION

It certainly was not the first time New Yorkers saw flashing lights atop the Empire State Building; but, it was the first time the lights danced as they did, synchronized to Alicia Keys' voice, her two tracks, "Girl on Fire" and "Empire State of Mind" selected appropriately for the launch of the building's newly installed programmable LED lighting system. Amidst the ambient glow of the surrounding buildings, bright orange and red hues shifted to blue, purple, and yellow to the pulsing beats of the music. The colours mixed and faded into one another, rippling across the façade and rising up and down the antennae to Keys' voice. As Megan Garber of *The Atlantic* described it, it was like "a fireworks show, with the illumination in question coming not from controlled explosions, but from controlled LEDs" [1]: a fireworks show that in its stoic silence could be completely ignored by thousands while also engaging a powerful centre of attention for those who knew what to look and listen for (tuning in to the synchronized audio on a local radio station), rippling out further into the night and onto the screens of those near and far via YouTube (see Figure 1), Instagram, Twitter, and Facebook.

Figure 1. Empire State Building, live light show with Alicia Keys, November 26, 2012, YouTube.

This evening in November of 2012 marked the beginning of an increasingly varied and experimental program of lighting atop the Empire State Building, a distinct shift in the lighting tradition of the tower that reaches back to its first years of operation in the

early 1930s. The Empire State Building's new lighting system can be seen as part of a larger shift in monumentality, urbanism, architecture, and digital culture characterized by the transformation of iconic buildings and significant architectural sites, such as Toronto's CN Tower or Paris' Eiffel Tower, by ever more elaborate, responsive media façades. An emerging collection of new, purpose-built structures, such as the Ars Electronic centre in Linz, Austria, and the Ryerson Image Arts Centre in Toronto, have also incorporated low-resolution, expressive surfaces into their façades.

In light of the growing importance of media architecture, specifically low-resolution media façades, that is, displays that are below resolutions for the reliable display of distinct images or text, this paper addresses the following research questions:

1. What is the historical relationship between low-resolution media architecture, such as the Empire State Building, and the experience of information in the city?
2. How can situated, functional, and informative [2] urban experiences be supported and sustained through contexts that include programmable low-resolution façades and associated media forms (ie. Twitter, Instagram, YouTube)?

The primary focus will be the Empire State Building, an iconic example of a structure with a long history of expressive, low-resolution public lighting. Analyzing social media traces, I identify how the building's lights are currently used by first examining the frequency of certain categories of use. I then isolate representative examples from the official @EmpireStateBldg Twitter and @empirestatebldg Instagram feeds to delve more deeply into the uses and transformations that this particular form presents. Finally, I present two of my works, *E-TOWER* (2010) and *In The Air, Tonight* (2014), reflecting on these as examples of research-creation inquiring into experimental or artistic uses of LED façades as public data visualizations. Throughout, other case studies serve to trace some of the contours of the history of low-resolution media architecture in the city and a literature review of current considerations and practices provides additional examples and evaluation criteria for the role of low-resolution media façades, particularly as they begin to emerge as sites for urban or public data visualizations. The criteria for evaluation stems from the work of Vande Moere and Hill [3] and Vande Moere and Wouters [4]. These authors outline the role that the environment, content, and carrier play in creating effective and sustainable media architecture, and the ways that public data visualizations can be situated, informative, and functional.

Media architecture, when combined with the expanding field of digital media — the "possibility machines" [5] that include all manner of ubiquitous computing and sensing devices, and the social networks that encourage their situated use — contribute to the formation of a "composite dispostif" [6] where screen spaces cooperate and compete in an increasingly geographically distributed, hybrid [7], and relational space [8], serving discourses that range from the commercial to the artistic and experimental. These expressive surfaces increase the ambivalence and contingency of the experience of space, enabling the formation of temporary publics through public data visualizations that combine elements of democratized urbanism, debate, emotion, control, and commerce and contribute to a state of supermodernism [9] in architecture and culture characterized by the irruption and imbrication of the "infoscape" and the cityscape.

2. THE EMPIRE STATE BUILDING

Although completed in 1931, it was not until 1932 that the Empire State Building installed its first proper lighting system. In November of that year, a searchlight beacon was installed to mark the election of native New Yorker, Franklin D. Roosevelt, to the office of the President of the United States of America [10]. In this new role as monumental information beacon the building signaled to Americans that they were united under the guiding light of a new administration. By combining the celebration of an election with a powerful symbol of civic pride, the lighting designers and management of the Empire State Building intensified the meaning of both in the process.

Yet, this combination of architectural lighting and public information was far from a novel phenomenon in 1932. The original plans for lighting the Empire State Building were influenced by the appearance of communicative and dynamic context specific light displays on other prominent buildings. By the 1920s, New York had buildings that incorporated flashing lights to transmit information: the Metropolitan Life tower on Madison Square and the Con Edison Building on Fourteenth Street flashed white every hour and red every quarter of an hour [11]. Douglas Leigh, the man responsible for creating numerous advertising "spectaculars" in Times Square and Broadway in the first half of the 20th century, sensed at the time "… an insatiable yearning for constantly knowing the time and temperature" [12] amongst the rapidly growing and circulating crowds of Manhattan. Building a seven story high thermometer for an ale company and a clock for the Gruen watch company were amongst Leigh's proposals for clients. Architectural lighting was a mark of sophistication and status for a building and the city. The dynamic floodlighting of the Empire State Building employed for the presidential election simply allowed the icon to "join ranks with others of its age" [13].

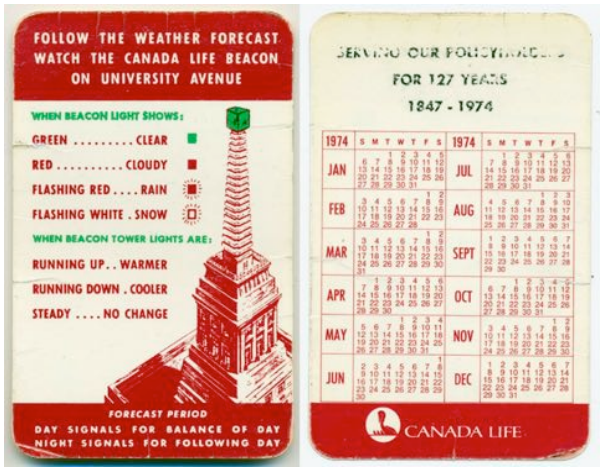

Figure 2. Screen capture of Twitter search for "empire state building" during 2012 election.

The Canada Life Building in Toronto, Canada (see Figure 2) is another example of the early use of expressive architectural lighting. Although the building itself opened in 1931, it wasn't until 1951 that a 12.5 m tall spire of lights was installed on its roof, 98 m above the street. The lighting system featured a long stem of yellow lights that were timed to create a rising or falling effect depending on the forecasted temperature. It also featured a tip that flashed red or white, indicating rain or snow respectively.

Solid green meant the weather ahead was clear, and solid red meant it was going to be overcast. The president of Canada Life, E.C. Gill, told the Toronto Star in 1951 that the building should provide both a useful service as well as a point of general interest and connection for people of the city. Said Gill, "For most people the weather provides a topic of conversation at all times" [14]. The Canada Life Building weather beacon extended this conversation with expressive architecture, elevating the building's status and visibility in the process.

Thus, from an early stage, architectural lighting could be seen as unifying, informing, and stimulating conversation amongst city dwellers while also elevating the status and centrality of structures and the organizations attached to them. Buildings such as the Empire State Building and the Canada Life Building extended the ability to collectively witness contextually relevant information in an urban environment. Additionally, by presenting a topic of conversation, architectural lighting enhancements went beyond providing useful information by creating a public, that is, a group of people witnessing and discussing the same information at the same time (Warner 2005), and a compliment to localized discussions and news reports on the building's lighting schemes and current events. Early public data visualizations created and re-centred publics by providing dynamic information that prompted urbanites to look with regularity, and to share the implications and outcomes of this contextually relevant public information with others, thus modulating the social life of the city, its inhabitants, and the status of its buildings.

3. COLOURS AND MEANINGS

In 1976, Time's Square's lighting impresario Douglas Leigh was serving as chairman of City Décor for the National Democratic Convention and the Bicentennial that year. Having once been denied an opportunity to work with the building's lights,[1] Leigh was determined not to be denied again. While looking for a way to celebrate the Bicentennial events he was presiding over, Leigh asked management to change the white lights atop the building to red, white, and blue. Leigh called it the application of "color with meaning" [16]. The new scheme proved to be quite popular. Architect Charles Linn said the building became "… the toast of the town" [17]. The success of the colour change set in motion a plan to expand the colours to include more "meanings." For Martin Luther King Jr. Day the tower glowed red, black, and green, for Valentine's Day, red and white, for Easter Week, white and yellow, for Police Memorials, blue, and so on. As Tauranac notes, "These colours became traditional as did celebrating specific events" [18]. In addition to these traditions, new uses for the lights and their semiotic potential were explored. In this inaugural year of expanded programming, a creative solution for celebrating the Camp David peace accord was presented where two sides of the building were lit in the state colours of Egypt, and the other two lit in the colours of Israel [19].

[1] Leigh had considered the Empire State Building as the canvas for one of his "spectaculars" but his pitch was eventually denied due to city wide restrictions resulting from America's entry into World War Two. As Tauranac notes about this failed pitch, "His dream was to light it like a cigarette, with ashes at the top and smoke curling up into the heavens, an advertising colossus created by a million white electric bulbs, a few thousand red lights to paint a burning tip against the night sky, and the Lucky Strike name emblazoned in neon on all four sides" [15].

In their expanded format, the lights now inserted the Empire State Building more deeply into the fabric of the city and culture, creating a focal point for a growing list of events, milestones, holidays, and causes, limited only by the investment of time and money required to change the lights — a six hour process that required a team of six workers [20]. The building became more sensitive and expressive of its unique time and place while developing and growing into a new purpose: a monumental marker of contextually relevant information.

Seventy years later, in 2012, the newly installed Philips Color Kinetics programmable LED lighting system, now capable of displaying an array of over 16 million colours in "virtually limitless combinations," all at the push of a "computer controlled" button [21], was called upon for yet another presidential election. Instead of simply and poetically indicating the result as it did in 1932, the building displayed an up-to-the-minute tally of votes during election night coordinated with real-time coverage on television, the Internet, and social media (see Figure 3). The CNN Press Room website described the lighting event as such:

> The four-sided tower, which sits atop the building more than a quarter of a mile from the streets of Manhattan, will be illuminated in patriotic red, white and blue vertical stripes, while the mast will be lit in blue and in red on two sides each to represent President Obama and Gov. Romney's respective electoral vote totals. CNN, which will exclusively shoot footage from the rooftop of a neighboring building, will air live images of the illuminated tower as the evening's results progress. When CNN projects a winner of the presidential election, the tower lights of the Empire State Building will change color to all-blue or to all-red. [22]

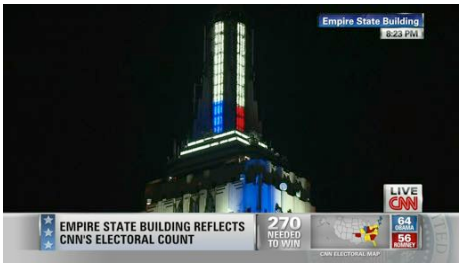

Figure 3. Empire State Building with CNN election results for Presidential election, 2012.

Massive changes in the media landscape over the past century (ie. satellite television, the Internet) meant that the building could now be a central figure not only in the city, but for countless social media posts and the epicenter of attention and action for one of the world's largest news networks on one of the biggest news nights of the decade. The detail of its message and meaning, and its amenability to appropriation and transformation by media outlets and prosumers had changed, and its status as a global icon was supported and reinforced in the coordinated and distributed mixture of local and global communication.

The agglomeration of media that saw the Empire State Building assume a prime position during the 2012 election as a massive data visualization, a big canvas for big data (and big media business), as well as the Alicia Keys event that officially kicked off the new lighting scheme, point to the expanded role that programmable low-resolution façades bring to architecture, space, and our relationship to it. Public lighting events and data visualizations, a category supported directly by lighting systems

such as those found on the Empire State Building, allow for expanded possibilities with respect to the buildings and spaces they occupy and the audiences they address, enabling a re-coding of space and a re-centering of local and geographically distributed audiences. As in the 1932 example, today's low-resolution media façades carry on a tradition that sees highly visible buildings as sites for the display of "public" information, albeit at an increased level of complexity that carries significance for our understanding of the possibilities and role of low-resolution media façades as public data visualizations.

4. CONTEMPORARY DIMENSIONS OF PUBLIC DATA VISUALIZATIONS

One way that the current complexity in expressive architecture has been theorized is through the concept of public data visualization. Vande Moere and Hill see the potential for public data visualizations, or what they call "urban visualizations," for improving the quality of life in cities by involving the local population in understanding the key drivers of urban issues [23]. The authors state that successful and effective urban visualizations must be *situated*, *informative*, and *functional*. An urban visualization is *situated* if it is embedded in a real-world environment and both borrows and contributes to it. As the authors note, if an urban visualization is properly situated, it should not require much in the way of a detailed explanation to be understood. For example, the urban visualization provided by *Pollstream-Nuage Vert* (2008) in Helsinki (see Figure 4), an installation that incorporated laser light to illuminate a proportion of CO_2 emissions emanating from a smoke stack based on local energy consumption levels, uses a symbol of energy consumption as its canvas in order to become more legible and impactful by borrowing from its cultural meaning. An urban visualization is *informative* if it allows onlookers to create meaningful insights or provide feedback. The aforementioned *Pollstream-Nuage Vert* certainly allows for the creation of meaningful insight, but does not directly provide a feedback mechanism, so it does not fully satisfy this criteria. Finally, an urban visualization is *functional* if it reaches a significantly large audience, does not impede other civic functions, blends into the urban fabric in a pleasing manner, provides trustworthy information by being fair, accurate, and revealing its sources, and is persuasive in some way, calling for some sort of reflection, change or action. Again, *Pollstream-Nuage Vert* is functional in that its scale allows it to reach a large audience, its presentation does not impede the functioning of the smoke stack, its sources are revealed to be fair and accurate on its website, and it is certainly persuasive in terms of encouraging energy saving measures.

Figure 4. *Pollstream-Nuage Vert* (2008).

In addition to functional, informational, and situational considerations, Vande Moere and Wouters [23] discuss the importance of overall *context* in media architecture by unpacking the shortcomings of a number of real-world examples. To do so, the authors focus on the importance of the interplay and cohesion between the *environment* (surrounding buildings, local culture, atmosphere), *content* (the information displayed and any interpretations that may be generated by it), and *carrier* (the building, square, façade, or any other element that supports the broadcast medium). They advocate for a "context-awareness" as a design characteristic for media architecture along these axes to ease the acceptance and efficacy of these structures in society so that they might be less susceptible to falling out of use or favour, something that they warn is a characteristic of media architecture in general. One example of media architecture failing to remain sustainable due to a change in *environment* and *carrier* context is that of the Dexia Tower in Brussels, Belgium. The 145m tall tower, with individually controllable LEDs creating a low-resolution façade, was initially the site of several artistic media installations, including *Weather Tower* (2008), an installation that turned weather data into abstract forms on the building. The tower has been unused since 2008 apart from a persistent 10-minute animation that runs sporadically to demonstrate the system's capabilities. The disuse of the Dexia Tower's LED façade coincided with the dramatic collapse of Dexia Group in 2011, and the bank has since decided that the change in the social perception of the company no longer allowed for the kinds of displays they had once sponsored and supported. Another example of contextual friction caused by media architecture is Media Screen Flagey Square, in Brussels, Belgium. The $12m^2$ screen had been vandalized with paint and its supply wires were set on fire on a number of occasions as a result of it being perceived as an unwanted "commercial invasion" for displaying ads for luxury retailers in a low-income area of the city. This represented a failure in contextual sensitivity with respect to the *content* and *environment* of the media façade.

Figure 5. *NOX* (2013), Ars Electronica Center.

One particular example that has remained effective in balancing environment, content, and carrier contexts throughout its relatively short existence is the Ars Electronica Center in Linz, Austria. The building, consisting of 1085 3'x1' back-lit glass panels, has consistently been used for artistic experimentation since 2009 (see Figure 5). One of ARS Electronica's most recent projects, *NOX* (2013), consisted of a cord suspended in the middle of a viewing area in front of the façade that, when pulled, turned all of the pixels on the building on or off. The simplicity of the installation posed an important question: are such façades seen as purely aesthetic embellishments and superficial gadgets layered over architecture, or are they an important shift in our urban fabric

that can make buildings more expressive of the actions and desires of citizens? It made the façade itself into an urban issue. The Ars Electronic Centre, with installations like *NOX*, points to the promises and pitfalls of digital communication (and communion), and the possibility for media façades to engender and engage community and debate through public data visualizations.

5. THE EMPIRE STATE BUILDING AS PUBLIC DATA VISULIZATION

In what ways does the Empire State Building fulfill these guidelines for pubic data visualizations? In the following section, I describe Empire State Building's current lighting program as well as its associated traces on Instagram and Twitter and use this information to address the criteria set out in the previous section.

An analysis of the data from the @EmpireLights Twitter feed, an unofficial account announcing daily lighting event information culled from the Empire State Building's official site,[2] shows that since 2009, when the first LED lighting system was installed (later upgraded in 2012), the lights have represented holidays, charitable causes, sporting events, commercial promotions, private lighting events, and other occasions (such as memorials or parades), while also defaulting back to "all tiers white" for "no occasion" in between all of these. The following graph (see Figure 6) presents a breakdown of these categorized uses based on a total of 1454 tweets collected from the account between 2009 and 2013.[3]

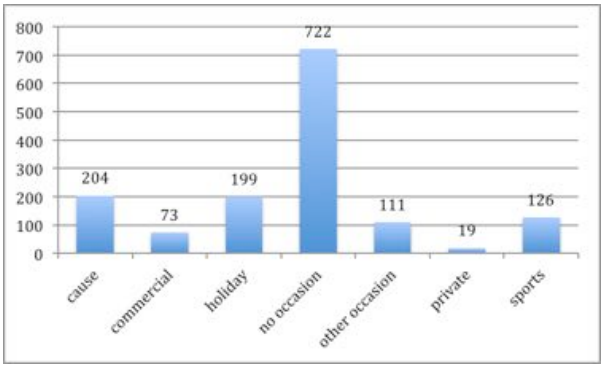

Figure 6. Categorized uses of the Empire State Building's lights, 2009-2013.

Examples of lighting programs characterized as a "cause" include events and milestones of not-for-profit organizations such as "@boyscouts 100th #Anniversary" (red, white, blue), and "Autism Awareness Month @autismspeaks" (all tiers blue). These represent 14% of the total uses. Commercial lighting events, representing 5% of the total, have included promotions for "Caribbean Week @ctotourism" (blue, green, yellow), and "@MammaMiaMusical's 10th anniversary" (blue, pink, white). Holiday lighting schemes, representing 14% of the total, have included multiple nights of "#Christmas" (red, green, green) and "#Hanukkah" (blue, white, blue). Approximately 50% of all lighting days have been "no occasion" (all white), although this has become less frequent over time. Other occasions have included "Mexican Independence Day @MCINY" (red, white, green), and "Family Day" (blue, red, blue), representing 8% of the total. Occasionally, the building's lights are used for private events or film shoots, although this represents less than 1% of total use since 2009. Finally, sporting events make up 9% of the total lighting schemes, with events such as "#SubwaySeries" baseball games featuring half of the tower in "blue, white, blue" for the Yankees and the other half "blue, orange, blue" for the city's other baseball team, the New York Mets. In addition to the categories listed above, there are specific examples that can fall under more than one category. For example, appeals to donate money to charity (@FoodBank4NYC) appear during Christmas and Thanksgiving lighting tweets. Commercial causes and charitable causes can also be mixed: EsteeLauder's #BreastCancer awareness campaign is one example (all tiers pink).

The Empire State Building has also included more dynamic and complex uses as a public data visualization. In addition to the public data visualization of the 2012 election, during a promotion for the 2014 Super Bowl in the week leading up to the game fans had the opportunity to pick which team's colours would appear each night by tweeting an answer (Broncos or Seahawks) to #WhosGonnaWin (see Figure 9). The information about how to participate, widely distributed online and through various media outlets, formed both the impetus to participate in a massive public data visualization and the means by which its meaning could be disseminated (not to mention a powerful tool for marketing the Super Bowl to be held in nearby New Jersey, The Empire State Building, and the official sponsor, Verizon).

Considering this specific instantiation of the building's lights in terms of Vende Moere and Hill's criteria, we can see the ways in which it is situated, informative, and functional. In terms of this visualization being *situated*, it existed in the midst of the hype surrounding the week leading up to the Super Bowl in the city in which it was to be hosted, thus having a direct and immediate relationship to the local context. That said, the data that was acquired extended beyond the local context, incorporating information gathered form fans around the globe. The visualization was *informative*, in that it created meaningful insights into the enthusiasm and support for either team. Finally, it was *functional* in that it was able to reach a large audience by virtue of the scale of the building in Manhattan and through the provision of online participation and promotion.

Furthermore, while the visualizations, causes, and events featured on the Empire State Building reflect issues that are closely relevant to the social-cultural reality in its vicinity, the building still requires the support of social media to reach its audience, that is, to be truly *situated*. For example, there is no difference whatsoever between the lights (blue, white, blue) used to celebrate Hanukkah, the Yankees, Columbia University commencement, or the 200th Anniversary of Argentina, except as indicated online. In this sense, the building, while being physically embedded and in relation to its physical environment and the social-cultural reality surrounding it, must be considered to be situated through the hybrid relationality of on and offline spaces. From this, we might conclude that the social-cultural environment of the building is necessarily a hybrid one, and that buildings such as The Empire State Building and its associated lighting and social media help to support and substantiate this condition.

[2] The official Empire State Building Twitter feed, @EmpireStateBldg, also tweets lighting information nightly, while interspersing these tweets with a large amount of non-lighting related information about events and activities at the venue. @EmpireLights was selected as it reports exclusively on the lighting scheme of the tower every night.

[3] The R statistical analysis program, along with the twitteR plugin, were used to gather historical tweet data from the @empirelights account. See http://www.r-project.org/ and http://cran.r-project.org/web/packages/twitteR/index.html.

By linking into an associated medium, particularly forums such as Twitter, Facebook, and Instagram, the Empire State Building integrates its media façade into the flows and associations of online discourse, expanding the reach, visibility, and function of the building as a public data visualization and monument. It engages with its *environment*, that is, its immediate vicinity in an expanded sense, one that includes online spaces, extends its *content*, that is, the information displayed via the LED lighting system, to online environments, and fulfills an augmented role as *carrier* in that it piggybacks on social media to support its broadcast, shaping the interpretation of the content it displays beyond immediate physical surroundings.

What follows are close readings of examples taken from Twitter and Instagram conversations related to the latest incarnation of the Empire State Building's lights. They demonstrate how relationships between an expanded environment-carrier-content context are stimulated and maintained through the relational spaces created by public data visualizations and associated media.

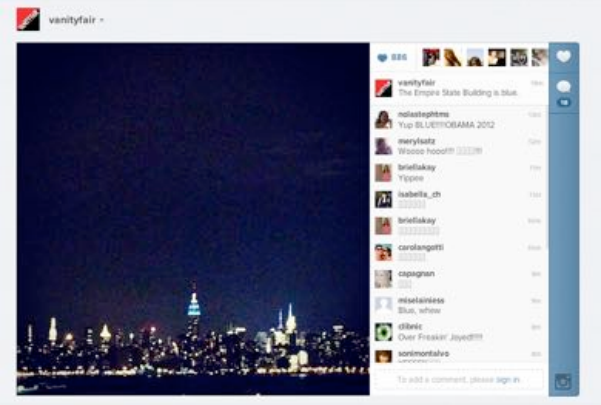

Figure 7. Screen capture of Empire State Building with blue lights indicating President Obama's victory in 2012 election, '@vanitfair', 2012, Instagram.

The first example is from the @vanityfair Instagram account (see Figure 7). It depicts the Empire State Building in the middle of the New York City skyline, lit in blue to indicate the victory of the democrat candidate, Barack Obama, in the 2012 presidential election. The text provided by @vanityfair simply states "The Empire State Building is blue" which means that those who responded must have heard about the meaning of the lights beforehand through another channel (Internet, Twitter, television, radio), word of mouth, or would have inferred its meaning from the fact that it was election night or from other comments on the post. Most of the comments are positive, with the open rectangular boxes depicted standing in for heart-shaped "emojis" that do not register outside of mobile devices. The comments here range from elation to relief. 886 people liked this post, and a total of 18 people commented on it, making it visible to their own followers in addition to those who follow the @vanityfair account. For a brief moment, until this post was buried under subsequent posts vying for attention and screen space, this composite of data visualization, social media, and monumental space took on an intensity and an emotional resonance, as well as an associated corporate value for entities such as Vanity Fair, the Empire State Building itself, and New York City.

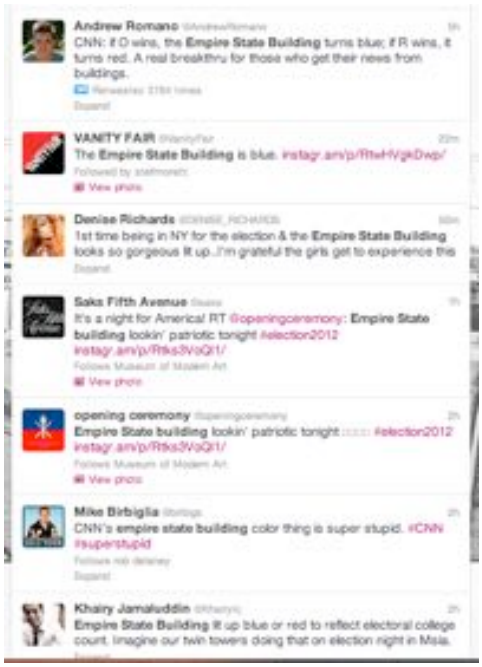

Figure 8. Screen capture of Twitter search for "empire state building" during 2012 election.

On Twitter, at roughly the same time as the Instagram post, a small sample of tweets containing the term "empire state building" provides a glimpse into how the election and the associated lighting event on the tower were discussed online (see Figure 8). Responses range from gratitude (from celebrity Denise Richards) to a tweet from Vanity Fair linking us back into the Instagram post discussed above. There is ridicule ("CNN's empire state building color thing is super stupid. #CNN #superstupid"), and even international envy ("Imagine our twin towers doing that on election night in [Malaysia]").

Figure 9. Screen capture of Nelson Mandela tribute on '@empirestatebldg', 2013, Instagram.

One final example involves a lighting configuration honouring South African political figure Nelson Mandela shortly after his death December 5, 2013. That night, the tower was lit in the colours of the South African flag (see Figure 9). Most of the associated comments were positive and supportive, yet there remain traces of dissent. As Instagram user cvtrapp writes, "South African colors on Pearl Harbor Day? Seriously? Mandela was an amazing man, but I'm not sure his death trumps that other attack

of terrorism/war in our country." Such comments show how the semiotic resource of the building and its lights, combined with the public function of its visibility, on and offline, and the facilitation of commenting and feedback, enable micro-publics of discussion, association, and debate within an expanded sense of carrier, content, and environment. Temporary nodes of intensity within increasingly contingent, networked spaces are created that extend the way that buildings like The Empire State Building can be considered to be situated, informative, and functional. The building becomes situated through a matrix of on and offline references (the status of the building as an icon, and its online status/followers), informative, by broadcasting information about causes and events through multiple, connected channels, and functional, by generating and facilitating communal, habitual communication and attention for the building and, from time to time, its sponsors.

Despite this, there are limits to the Empire State Building's ability to function as a *public* data visualization. One of the key concerns with all media forms, and media architecture is no exception, is access and moderation. While the Twitter, Instagram, and Facebook feeds related to the Empire State Building remain relatively un-moderated, protocols and procedures for determining what gets commemorated and represented by the lights remains highly controlled by the building's management. The Empire State Building's gatekeeping structures[4] must balance its role as private entity and public icon carefully. While the building does entertain lighting requests, they clearly state that the building is privately owned and thus has its own selection and review policies. These include maintaining full discretion over selection, and denying any requests for political figures and campaigns, religious figures, organizations, and holidays outside of the holidays they sanction (Easter, Eid al Fitr, Hanukah, and Christmas).

Of course, in examples such as #WhosGonnaWin, control over the lighting scheme is given over to the masses of sports fans willing to vote for turning the building the colour of their preferred team. While access is granted, it is ultimately brokered by the sponsor, Verizon, and limited to two choices whose referent has been predetermined. Similarly, in the CNN election example, the buildings lights are made to be dynamically responsive, but the choice of the lighting program is ultimately out of the hands of the public. While election information does provide an informative function, in terms of data visualization, the participation afforded to the citizen by the public visualization is merely a token and does not, and can not, reflect the direct result of an individual's participation.

That said, even this diluted form of interaction with buildings allows for the formulation of new kinds of publics that merge the embodied experience of the urban with "disembodied" online experience. The result is a "(re)embodiment through technics" [25] which creates a new connection and a new register of "being together" publicly, and results in new rituals of monumentality, commemoration, awareness, and commercialism. A building like the Empire State Building collects on and offline audiences and their associated techno-social capabilities, allowing for a diversity of discourses. It does so potently through the effect of making the building either directly or indirectly representative of a collection of individual impulses or by being available for temporary recoding and appropriation. The city becomes more communicative, and more communal in that it becomes a shared resource and a critical site for the formation, moderation, and critique of what we might consider public debate and civic identification today. Sutured as we are to the means to decode and interact with these buildings (via mobile ubiquitous media) we become avant-garde readers and writers in the contingent, ambivalent city, regardless of our location, creating small but powerful associations and intensities.

[4] See the "lighting partner" application for the Empire State Building http://www.esbnyc.com/pr-pop-culture/tower-lighting-request.

6. RESEARCH-CREATION: SOCIALLY-ENGAGED PUBLIC DATA VISUALIZATION

While the development of the Empire State Building's lighting program expresses and engages new possibilities for the confluence of media façades and ubiquitous media, questions remain: how can the use of similar façades better translate and direct our current dynamic reality towards artistic, political, and social ends? How can a low-resolution media façade better engage a democratized urbanism, engender debate, or elicit emotion? I have pursued this question through a program of research-creation that includes the creation of two large-scale, participatory public data visualizations. In this section, I describe these projects and indicate and evaluate their role as public data visualizations.

Figure 10. *E-TOWER* (2010), Dave Colangelo and Patricio Davila, CN Tower, Toronto.

E-TOWER (2010), completed with collaborator Patricio Davila, was an interactive cell-phone based installation with one of the tallest and most visible low-resolution LED façades in the world, Toronto's CN Tower (see Figure 10). The CN Tower, initially built in the 1970s to boost television and radio broadcast signals and create a landmark for the growing city, was outfitted with a computer controlled LED lighting system in 2007 and has since followed a similar trajectory as the Empire State Building, commemorating holidays, special events, memorials, and special causes, while otherwise defaulting to its signature red colour to symbolize Canada.

After a period of negotiation with the tower's management and careful vetting and revision of our concept, as well as securing technical support and sponsorship from one of Canada's largest telecommunication companies, Rogers Communications, we were granted access to the system to present the work on the night of Nuit Blanche 2010, an all-night art party held in Toronto. From sundown to sunrise, *E-TOWER* visualized the collective energy of the city on the most visible symbol of the city (*carrier*) by asking participants to text the word 'energy' to a specific number,

making the lights on the tower grow faster and glow brighter.[5] Throughout the night, individuals and groups participated by sending their "energy" to the tower (*content*), creating links across physical space, in proximity and at a distance (*environment*), sutured together by mobile phone technology and the tower as a shared representational and communicative beacon. *E-TOWER* allowed the city to communicate to itself with itself (*situated*) through a visualization combining data, architecture, and urban space. By using the CN Tower as the central transfer point for the city's participation, people's actions were mapped on to a powerful civic symbol. *E-TOWER* coordinated the diverse and distributed screens of participants with the tower as a central visualization, using the visibility and centrality of the tower and the ubiquity of phones to create an attractive experience and a specific gathering point for identification and participation. It was able to create and make collectivity and connection massively attractive and apparent (*informative* and *functional*).

Figure 11. *In The Air, Tonight* (2014), Dave Colangelo and Patricio Davila, Ryerson Image Centre, Toronto.

For our next project, we partnered with the Ryerson Image Centre, a newly renovated building with a computer controlled low-resolution LED façade on the campus of Ryerson University in downtown Toronto. Although the building was owned and operated by the university and had yet to display content outside of ambient pre-set patterns and school colours, the administration of the building was open to allowing us to test some new possibilities since they were not beholden to sponsors and other corporate stakeholders.

This access and freedom from moderation allowed us to present *In The Air, Tonight* (2014) (see Figure 11).[6] For one month, during one of the coldest winters on record in Toronto, the LED façade of the Ryerson Image Centre (*carrier*) was animated with a blue wave representing wind speed and direction while an intermittent red pulse was triggered by fluctuations in the use of #homelessness on Twitter (*content*). By visiting intheairtonight.org people could read and retweet messages from our Twitter feed (@itat2014) or compose their own message. Every message with the hashtag #homelessness amplified the issue online and contributed to a colour change on the building (*environment*). Our goal with this project was to foreground a pressing social and civic issue through networks and architecture, negotiating access to both, and providing an interface that allowed people to engage with and contribute to amplifying an area of common concern. A key component of this project was to seek out experts in the field to help populate and seed the Twitter feed during the duration of the installation to enrich the public sphere we were attempting to create. Another main component was making connections with drop-in-centres and homeless shelters in the area around the building that provide computer and Internet access in order to allow those directly experiencing and affected by this issue to participate on relatively equal footing.

The results were mixed. While many people engaged with the project online through Twitter and through media outlets that had written about the installation, participation and awareness of the installation at the site was limited. What the project lacked was a strong physical referent, or associated physical medium at the site in order to make the data visualization more self-evident: to make it more *situated*. Unlike the *NOX* project at Ars Electronica, where a simple pull evoked quite clearly the function and purpose of pulling it, the lights on the Ryerson Image Centre building did not self-evidently refer to information about homelessness. While it existed at the centre of the highest concentration of drop-in centres and shelters in the city, this much was not clear by simply looking at the building. That said, *In The Air, Tonight* was *informative* in that it was clearly responsive to tweets, yet was not necessarily insightful, in the sense that it did not allow onlookers to create meaningful insights about the problem of homelessness. Instead, it allowed them to do so only if they engaged in the online component of the work and followed links and tweets served up on the interface. Finally, *In The Air, Tonight*, could be said to be somewhat *functional* in that it was aesthetically pleasing, and was persuasive for those that had deciphered its meaning. At the same time, the project was *functional* in that it was able to reach a larger audience by tapping into other associated media: it was able to capture media attention (radio, blogs) from outlets that would not necessarily be concerned with poverty and homelessness [26] [27] and did increase the prevalence of the hashtag "homelessness" online, making the issue more visible on many fronts. As such it extended the environment-carrier-content meshwork across on and offline space, thus extending the reach and impact of the project. It also led to many connections between experts and activists in the field that became aware of one another via the Twitter stream. In short, the low-resolution media façade event was the impetus for the formation of diverse, temporary publics and publicity.

7. DISCUSSION: MEDIA ARCHITECTURE AND SUPERMODERNISM

Low-resolution programmable façades such as the one atop the Empire State Building, the CN Tower, and the Ryerson Image Center create and support a hybrid and relational space that activates the expressivity, networked digitality, and liveness afforded by such displays to engage in an emerging and important practice of public data visualization. The visibility and monumentality of architecture is important in that the power it affords can be harnessed and redirected. Scale and physicality give a new shape, form, and context to data. At the same time, data can give a new shape, form, and context to space. Data becomes something a body can feel because it can measure it in relation to itself (big data can be *big*), and distributed communication can appear more communal. In this way, large, low-resolution programmable façades are a digital-era update to things like weather beacons and TV towers, except they are exponentially more expressive and communicative, especially through associated technologies and networks of ubiquitous social media.

[5] See http://www.etower.ca/ for documentation of the work.
[6] See http://davecolangelo.com/project/in-the-air-tonight/ for documentation of the work.

Programmable architectural light façades are thus suggestive of supermodernism, a movement in architecture that involves a new epoch of urban form characterized by buildings seen increasingly as communicative systems that prioritize direct, contextually relevant experience [28] and thus seek to re-inject specificity and connection into physical environments. Supermodernism shifts the traditional notion of architectonics [29], a term that describes the degree to which the material composition and symbolic expression of a building reflect its history and context, to include a responsiveness to data flows in the "surrounding information environment" [30], making this data concrete through a spatial expression and the experience of data against the body in space. While others, such as Virilio and Augé [31] have warned that technology has set architectonics adrift, "exhil[ing] all of us from the terrestrial horizon" [32], Ibelings [33] and Krajewski [34] focus instead on ways to take back the power of public space to encode meaning by suffusing it with data, and remain more optimistic about the importance and potential of buildings that can translate or reflect our present dynamic reality in some way.

Apart from providing opportunities for communal commemoration, celebration, and augmenting the presentation of data through context and scale, as buildings such as the Empire State Building and the CN Tower demonstrate, public data visualizations can also play the important and necessary role of allowing data to surface symbolically and circulate technically in ways that are sensible at sites and scales befitting their effects and importance in contemporary life. While low-resolution architectural façades may be similar to weather beacons and TV towers in that they "signify a proximity to technological advancement" [35] of a certain time (and thus provide an intrinsic value to city builders), they do more than signify: they converse, because they have a public face, a façade that talks, and, to a degree, listens. This, in the end, is what makes them supermodern; they are increasingly seen as important parts of communicative systems, and are meeting places for people and things that embody and engender the coming together of mediated communication in its myriad forms.

8. CONCLUSION

Although this paper is the first case study of the Empire State Building's LED façade and the first study that analyzes social media as an important associated technology of media façades, particularly those with low-resolution displays, these emerging media architecture experiences and practices must continue to be analyzed and critiqued through observation, analysis, and practice so we might better understand their role and potential in a data society, and their role in constructing and commodifying urban identities for people and places.

LED façades are the most recent examples of a rich history of large, dynamic, low-resolution public displays. The expanded capabilities of these façades, coupled with an associated technological milieu which includes mobile ubiquitous media, ever-expanding contextually relevant data sets, and social networking allows for a more dynamic relationship between people, the city, and information. Massive, programmable low-resolution façades, such the one atop the Empire State Building, code and recode space in their ever shifting messages and meanings, and allow people to associate (or disassociate) with the city in novel ways while also allowing data to surface through public data visualizations that are situated, informative, and functional. Buildings with media façades thus become dense transfer points for digital culture, as well as for the emotions and identification of diverse groups. By harnessing the direct participation of publics through social networking they usher in an era of supermodern architecture, occupying a central role in the formation of temporary intensities within an increasingly relational space characterized by ambivalence and contingency [36], extending the environment-carrier-content meshwork of public data visualizations into hybrid on and offline spaces. The intensities created by such assemblages can be directed towards various ends, which, depending on the conditions of ownership and control — perhaps the greatest determining factor in the use and outcome of these assemblages — vary from the overtly commercial to the artistic, experimental, and critical. Buildings can become semiotic resources for socially engaged practices provided that the proper permissions are negotiated and that consideration is given to equitable representation. Artists and designers engaged in socially engaged practice with low-resolution media architecture must see as their primary objective the furnishing and harnessing of technologies and points of access which include public space, architecture, various fixed and mobile sensors, and networks, to facilitate and amplify collective conversations around issues of common concern.

9. ACKNOWLEDGMENTS

I would like to thank the Social Sciences and Humanities Research Council of Canada (SSHRC), OCAD University, and Ryerson University for supporting this research.

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City Bug Report: Urban prototyping as participatory process and practice

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ABSTRACT
This paper explores the wider contexts of digital policy, transparency, digitisation and how this changes city administration and the role of the (digital) publics, using City Bug Report as a design case. Employing a mix between design research and action research, the authors exemplify and analyse elements of both the design process, the organizational, the political and technological contexts. They point to the role of researchers and designers in exploring and understanding digital elements of public space as not merely registering structures but also actively engaging in public discourse, providing critique and alternatives as much as solutions. Further research and challenges are discussed.

Author Keywords
Media architecture; Digital Publics; Design explorations; Urban Interaction Design;

ACM Classification Keywords
H.5.m. Information Interfaces and Presentation (e.g. HCI): Miscellaneous

INTRODUCTION AND MOTIVATION
Media faades are just one of many ways in which digitisation and novel digital technologies are transforming urban space and how we experience cities. As researchers within the relatively new field of urban interaction design [7], the city and the urban space gives us amble opportunity for studying how passers-by interact with media façades and urban screens and how information can be displayed and made interactive. Researchers and practitioners within the field of media architecture and (urban) interaction design have provided rich insights into and methods for how designing and developing media façades and public displays [10, 27, 23], the role of context, content and interaction [14, 25], how media faades can benefit from or be made more engaging and interactive [8, 31, 6], how to evaluate public displays [1] and outlined key challenges when designing media façades[9]. Moreover, Fisher et al.[15] and Fritsch & Dalsgaard[18] argue for moving beyond both interaction, information and utility, and provides interesting topics for further research into the role of media façades and architecture in transforming the public space, spatial models, affective experience and engaging interaction. Thus, the research within the area of media architecture and façades have already made a broad and rich contribution in understanding what happens behind the scene (technology), on the screen (medium/content), in front of the screen (interaction) and potential role in the public urban space (urban experience).

However, when scaling our research interventions to the facade, urban space and the city, the challenges and implications go beyond the spatial context, the technical infrastructure and the directly involved stakeholders. The design and deployment of a media façade becomes entangled in and conditioned by organisational, political, policy, historical and cultural circumstances, where decisions directly and indirectly affecting media architecture, digital technologies and the (digital) urban space are in the hands of actors outside the core project group, e.g. city administration, authorities, urban planners, and is conditioned by both existing policies, historical and local circumstances and relations. Dalsgaard Halskov[9] touch upon these as challenges related to aligning stakeholders and balancing interests, not only within the primary group of stakeholders (e.g. designers, architects, technology providers and building owners/developers), but also between policy and regulation (e.g. city architectural policy, traffic regulation and urban branding). Similarly, Korsgaard et al.[23] describe how the final decision regarding the conceptual design of a potential media fa{cade in Stockholm was effectively in the hands of the Stockholm city architect. Fatah Gen. Schieck [14] sees the planning system, urban planners and policy makers as gatekeepers in ensuring a sustainable implementation and integration of media screens in the built environment and calls for the (research) community to engage with the planning system and the development of appropriate strategies. We share Fatah Gen. Schiecks position and argue that media architecture and urban interaction design should expand the scope beyond the research themes outline above, and use media architecture as an opportunity to explore the broader political and urban context, thus pushing larger topics related to digital policy, transparency, digitisation and how this changes city administration and the role of emerging (digital) publics.

In the following we present the design case *"City Bug Report"*, a media façade on the city hall tower in Aarhus, Denmark and a online/mobile platform for citizen feedback and reporting issues within the city, regarding any facet of city life. The two constituents (media faade and online/mobile platform) were not technically connected, but share a thematic and semantic link, as the media façade at the city hall tower *outputs* a visualisation of actual open records on civic communication between the city departments and citizens, whereas the web-based cross-platform reporting tool acts as the *input* for said municipal departments around any issue citizens perceive as matters for the city. As such, the media façade and reporting tool is strongly embedded in a political context it is installed on a iconic landmark on the facade of a building housing both the civil service and city council, with content based on the municipalitys ability to manage and respond to enquiries from citizens, and the online feedback and reporting tool offers a public platform for bringing issues to the attention of the municipality and the public. In this particular case, the research agenda is to explore media architecture and tools for citizen engagement and feedback as interfaces between city and citizens, and to understand the role of media architecture as a strategy for prototyping or probing into the digital maturity, policy and notions of transparency at the scale of a city.

The contribution of this paper is first and foremost a thorough account of the media architecture case, findings and reflections, and a discussion of how media architecture can act as a touch point between city stakeholders and means for exploring challenges and implications regarding city policy, transparency and digitalisation. The latter requires some broader contextualisation and reflections, as as the process which led to getting 5.500 LEDs mounted on the cultural heritage landmark city hall tower in Aarhus, showing actual information on communications between the municipality and citizens, within a very short timeframe, was rather complex and unsystematic. On a side-note, this, we often find to be the case when engaging in real-world development.

Figure 1. City Bug Report media façade at City Hall Aarhus

The paper is structured as follows: First we present our research approach, followed by a presentation of the design case. This leads to a reflection on and discussion the case, findings, challenges and further research in relation to the research agenda and contribution outlined above.

RESEARCH METHODOLOGY

The research methodology is a mix between action research and design research (cf. e.g. [21, 5, 16]), both traditions emphasising change through action. In interaction design research, change often comes both as a novel technology and the socio-technical changes brought about by new artefacts, which, in turn, is a result of a longer collaboration between the involved stakeholders. Both the resulting artefact and the co-design and collaboration in itself are means to investigating the research themes and attempts to suggest alternatives to and engage critically with existing assumptions and current situation. The notion of *urban prototypes* are strongly influenced by what Fallman[13] call *design-oriented research*, where the artefact and the underlying design process are seen as means to understand and investigate both the now the existing socio-technical context, issues related to normative values, assumptions, world views and political and organisational tensions and possible futures, including situating them in complex contexts. The insights gained from design-oriented research could be knowledge for designers e.g. new methodologies, design techniques, implications for design and design exemplars as often emphasised by research through design [4, 32] or insights into the existing socio-technical context, assumptions on the role of technology and society at large, leaning more towards critical approaches, such as provotypes[26] and critical design[12, 3]. Hayes[20] note a similar distinction between design and research in his review and discussion of action research in Human-Computer Interaction. She states clearly that the end product of action research is scholarly knowledge and not a technological artefact as in software development, even though the latter may include participatory or iterative approaches. We understand and articulate urban prototypes in the same way Hutchinson et al. [22] presents *technology probes* as a particular kind of probe that combine goals from social science, engineering and design research but with a key difference. While technology probes focuses partly on gathering data from the users, urban prototypes are intended for provoking and probing reactions from the stakeholders directly and in-directly involved in the project, as media architecture go beyond users and enters a larger socio-technical context. Following Hayes, and action research, our research approach embraces that research is value-laden, intervening, represents more than a strict research agenda and has a strong commitment to the particular localised problems at hand. Here Hayes emphasises openness and transparency in the research agenda and both the necessity to formulate and perform the research with the people experiencing the problems.

In the present case, the most tangible and concrete outcome is a particular technological artefact, a media faade and an online tool. These artefacts are used as a means to examine and discuss some of the underlying assumptions around intangible notions of digital transparency, open data and civic communication in a governance context. While much of the technology and the placement of the media façade was

given beforehand, we used a two-day workshop with participants from the municipality, industry, the region and the university to develop a conceptual frame focusing on open data and transparency as both design and research concepts which we wanted to understand and investigate in the context of Aarhus and the municipality. The key design concept the idea of visualising and working with issues pertinent to the city emerged from the workshop and was further co-developed with the involved stakeholders. From a research perspective, we see this collaborative approach and the continuous dialogue throughout the process as the prime source of insight on the socio-technical changes brought by the case. Following the project we conducted two longer interviews focusing on the impact of the project on the involved municipality departments and confirming our observations throughout the collaboration. In this paper we will include the responses on a reflective and anecdotal level, due to the low number of interviews and their focus.

CASE: CITY BUG REPORT

The project was born when AHL Lighting Group Limited[1] offered to sponsor 5500 LEDs for the media Media Architecture Biennale 2012 (MAB12) in Aarhus. Together with the municipality we got approval for transforming the iconic city hall tower into a media façade during the biennale running from the 15th to the 17th of November 2012. While the technology and the site was given from the onset we had completely free hands regarding the design of the façade and the content. In 2012 the city of Aarhus launched both a smart city initiative, Smart Aarhus[2] and the open data platform Open Data Aarhus (ODAA)[3], a process the authors were heavily involved in, and we wanted to use the media façade as an opportunity to work with the stakeholders within Smart Aarhus to explore both the potential and challenges in open data and digital transparency.

In September 2012 we invited key stakeholders within Smart Aarhus, local industry, researchers, design students and others to a two-day workshop on open data. The workshop was facilitated by journalist and technology author Ben Hammersley, and the aim was firstly to open up a dialogue on and explore different topics related to open data with the participants, and secondly to develop a focus and series of design concepts for the façade at city hall. The first day was spent exploring which data were interesting for a city and local stakeholders, how and where they could be gathered and what they could be used for which imminent challenges and potential the group could see emerge from the shared exploration and analysis. In the second day, the preliminarily analysis where brought into the context of the media faade on the city hall tower as a design task. The participants developed six design concepts from which the final concept was further developed in terms of how the citizens would use the tool, the role of citizen service and other municipal departments, available data and needed infrastructure. The workshop provided two concrete outcomes for the design case: A conceptual design for the media faade with the working title *City Bug Report*, and a shared analysis around open data, transparency and civic communication that served as a further inspiration for our research focus.

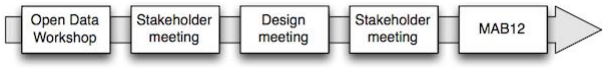

Figure 2. City Bug Report design process

The concept was further developed and refined together with the primary stakeholders: Citizen Service department within the municipality, ODAA, Media Architecture Institute (MAI), a local business intelligence company D60 and us as researchers from Centre for Advanced Visualisation and Interaction (CAVI) and Participatory IT (PIT) at Aarhus University. CAVI and MAI took care of the technical design of the media façade, while CAVI, D60 and ODAA focused on the bug reporting platform, data analysis and content for the façade. Each part of the project was developed throughout a series of design and stakeholder meetings throughout October and November. Citizen Service contributed with the data for the façade and helped co-design the bug reporting platform.

Figure 3. Poster outside the Citizen Service office at City Hall

The initial concept was very simple, we wanted to provide the municipality with a tool that could help map issues within the city with the help of the citizens. Unlike tools such as FixMyStreet[4], we wanted to go beyond simple issues such as potholes and broken pavement and provide the opportunity to report all issues: day-care, health, culture, libraries, slowly moving away from the built environment and into areas and budgets closer to policy-making and more complicated issues. Another aspect in moving beyond a platform for

[1] http://www.ledahl.net/
[2] http://www.smartaarhus.eu/
[3] http://www.odaa.dk/
[4] http://www.fixmystreet.com/

reporting straightforward problems and then leaving it to the municipality to fix it, preferably as soon as possible, where to make one report visible to other citizens and maybe even other stakeholders within the city and generate a conversation regarding the issue. A part of the concept proposed by the Citizen Service, was to use the platform as a way to either pre-qualify an issue, e.g. how many citizens acknowledge and agreed that the issue indeed where an matter of concern? to whom was it a problem and why?, and what where the potential concerns and implications?, or as a place where local stakeholders, e.g. journalists, NGOs, communities, start-ups and companies, could find important issues or potential suggestions for solving a specific issue in a more open manner.

With the title, City Bug Report, we draw inspiration from software development, where a "bug" denotes some form of flaw, error or unintended behaviour in a specific system caused by errors in the source code, bad design or issues related to interoperability across systems and code. In software development bugs present a huge challenge and it is impossible to make a completely bug free system, as many of the issues surfaces after deployment and when the software is in use. Therefor it has become acceptable that bugs exist, think of the infamous Blue Screen of Death error screen from previous versions of the Windows operating system. One strategy for finding, identifying and solving software bugs, is to let developers, early users in pre-release phases (so-called alpha and beta phases), and even end-users report these errors in different reporting tools and wikis, such as the Linux distribution Ubuntus Launchpad[5] or the more generic Bugzilla[6]. We have adopted the term inspired by the community supported and crowdsourcing approach in software development, the use of digital tools and because we regard the city as a larger system that never reaches a state of fixed it is always "broken" for someone somewhere. Moreover, we wanted to have a link between the tool and the media faade, preferably with live data coming from the reporting tool and the citizens themselves. However, this proved difficult, mainly due to the lack of real data when producing the animation for the facade and the risk that there might not be anything to show for the first few days until the bug reporting tool where more widely used, if at all. We did implement the technical link between the platform and the media faade during the biennale, but we never made use of it as the existing installation was working to our satisfaction and due to the low traffic on the bug reporting platform. Instead we chose to use existing data on civic communication around issues and requests on the façade provided by the Citizen Service department and then connecting what happened at the tower with the bug reporting tool via a poster below the tower and outside the Citizen Service office, see figure 3. The poster is thus a more semantic link, creating a narrative around the media façade and the bug reporting tool, with an open invitation to participate and a link (URL and QR code) to the bug reporting tool.

With the visualisation on the media façade, we wanted to show not only the successful, timely and well-managed communication between the city and citizens, but also highlight some of the instances where the communication was complicated, either by the nature of the citizen request or the complexity of the internal workflow within the municipality. We envisioned the city hall as a kind of barometer or yardstick for the health and maturity of the digital communication and transparency between the public, citizens and the municipality. If any of the visual representations of the communication raised the top of the tower (i.e. the upper ribbon on the media façade) the communication was slow and requests made by citizens may even be left unanswered, while quicker movements and colour changes between red and blue on the lower ribbons indicated more timely and responsive communication. An ideal scenario from the perspective of the municipality would be thriving activity on the lower levels of the media faade, indicating maturity in terms of digital civic communication and openness towards requests from the public.

Media Façade

The media façade is comprised of 5496 full RGB AHL S25-3 LED pixels distributed onto 13 segments each comprised of either 57*8 LEDs or 48*8 LEDs, with a pixel pitch of 20 centimetres. The pixel LEDs was controlled by four AHL CP950 controllers. Each LED was fastened on a metal wire grid mounted on the outside of the existing railing at the city hall tower.

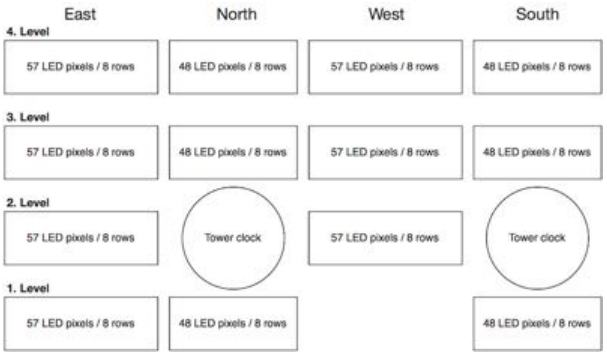

Figure 4. Façade design and LED segments

Figure 4 shows the distribution of the LED segments around the tower, with four vertical segments facing the street (east), three on the park side (west) and three on each side with the clock generating a gab in the media façade.

The content of the faade was a time lapse of specific online communication between the municipality departments and citizens. The municipality of Aarhus have a service called "Postlisten"[7] (literally, the mail-list), where citizens can direct inquires towards the city on specific matters via either email or traditional mail. Once a citizens has made an inquiry, e.g. requesting information, seeking a special permit, generating awareness complaining on specific issues, the municipality is legally obliged to give an answer within two weeks. The answer may come in different ways depending on the inquiry. Sometimes a question is straightforward to answer,

[5]https://help.ubuntu.com/community/Launchpad
[6]http://www.bugzilla.org/
[7]http://www.aarhus.dk/da/omkommunen/nyheder/Postlister.aspx

Figure 5. Media Façade at City Hall Tower

while others need to circulate throughout different departments and areas within the municipality. A special permit might involve both the technical-, fire- and legal department, and may span several replies from the municipality, while an inquiry on using a school for accommodation at a sports event only requires a single response. Moreover, once something is registered and put on Postlisten, it is open to the public via the municipality website and was frequently used by local news reporters as a source on smaller cases within the municipality.

The time lapsed animation showed four years of communication on Postlisten. The data was parsed and filtered for anything but the case ID, the number of replies and their dates. In the final dataset used for the animation, each case was comprised of the case ID and a number of transactions, with date and direction, i.e. *incoming* if the communication was from the citizen or *outgoing* if the communication was from a city department involved in the case. We chose the colour red to signify incoming request made by a citizen to the city, and the colour blue to signify a response from the city departments to the citizen. The data spanned four years and was compressed into a time lapse animation lasting an hour. This was repeated throughout the running time of the installation. The animation was designed so that when a case was born, that is when the first occurrence was registered in the data based on the citizen request, a red dot would spawn on the lowest ribbon of the facade. It would then travel horizontal alongside the ribbon and around the tower until a new occurrence happened on the same id. This could be either a second incoming request from a citizen or an outgoing response from the city. If it was a second request from a citizen the dot would retain the red colour, grow a bit in size and jump up to the next ribbon on the tower. It the occurrence was a response from the city, the dot would still move up and grow, but change colour to blue indicating a response from the city. The dot would continue to move up, grow and change colour as long as there where transactions on that particular case ID. If the dot reached the final transaction, it would keep moving around the ribbon for a fixed duration time before disappearing from the façade. A larger white dot would flash every time a new dot was spawned or when a dot disappeared. If the dot reached the upper ribbon it would travel for an extended time and reach the final size regardless of colour. As mentioned in the concept description, the dots should remain at the lower ribbons and stay blue, indicating quick and uncomplicated response from the municipality, and not end up being large red dots at the upper ribbon, indicating slow or lacking response at all to the citizen request from the municipality.

Bug reporting tool

The bug reporting tool is a simple web-based tool designed for both desktop computers and smartphones. It allowed anyone to explore existing bugs, report new ones and share a specific report via social media (e.g. Twitter and Facebook). When reporting a bug, the user is presented with a tiled interface with different categories mirroring some of the existing responsibilities within the municipality and new ones identified together with Citizen Service department, see figure 6. The categories range from very traditional areas within the technical department, e.g. roads, signage, utilities, over family, school, citizen service, health and housing, to culture, libraries, public websites and finally a miscellaneous category to catch anything that do not fit the existing. Upon choosing a category, the user is taken to a traditional web-form with three fields, a headline, a description of the problem and a suggestion for improvement. Final page before submitting the report contains fields for contact information, name, email, phone, a checkbox where the user allow further contact regarding the issues and possible solutions and finally a Recaptcha filter. The headline and base description was required fields for reporting a bug, while the contact information was set as required fields and validated as a way of curating the contribution. Once the bug is reported the bug is visible on the list with the given information, see figure 8.

It is also possible to see the total list of reported bugs and go into each one for more information. This is best done via the desktop browser, see figure 7. The purpose here was more to browse the existing bug reports and share these on social media as a way of discussing the issue and further suggest solutions. When designing the visual identity of the design we wanted it to be clearly separated from the design guidelines for the municipality and the municipality website. We used graphical elements to indicate that this was more a platform

Figure 6. Smartphone interface for City Bug Report

for the city and citizens as a whole, and not just a different municipality website.

Figure 7. Browser interface for City Bug Report

Findings

23 bugs was reported in the running period. When filtering away bugs submitted by people clearly testing or playing with the tool, we ended up with 14 legitimate bug reports. After the first few weeks the where flooded by spam in spite of the Recaptcha filter. Of the 14 bugs, 12 did put in both a description and a suggestion for a solution. We have not accessed the viability or quality of the solution, it only shows that contributors not only have issues, but are also capable of and willing to suggest an improvement. The 14 reports can very clearly be divided into bugs related to the build environment and traffic, and the reports relating to a particular political case regarding the closing of a specific school in Aarhus. Four of the bugs are pointing out that it is a wrong decision to close the particular school and only one of these provides a suggestion for addressing the problem. The language in the bugs also varies from concrete and specific descriptions

Figure 8. Example bug report

of the matter, e.g. describing the street where the bug is occurring or how the markings the pavement are endangering cyclists, over pointing our more general issues, e.g. the parking or traffic situation in the city is unbearable, to mocking or protesting against specific decisions. The last was most dominant around the more political or general issues.

When discussing the concept with the participants from the Citizen Service, and later the communications department within the municipality, three major concerns where raised. The first issue was raised early in the project when the first test version of the bug reporting platform was presented. The Citizen Service department and participants from other municipality departments, that participated through ODAA, where concerned on how to deal with the incoming bug reports. Where the city obliged to fix everything? Who would be responsible within each department how would the day to day operation be integrated in such a tool. In the subsequent interview, the participant from Citizen Service reflected on this issue in terms of the internal workflow and organisational design of the municipality. The respondent reflected on a more finalised version of the tool and what other elements that should be in place for such a tool being well-integrated and valuable for the municipality. Such a tool would both require clear internal and external documentation and communication regarding what would and would not be an issue the municipality should take care of, as well as requiring an organisational design that allowed more direct communication, coordination and collaboration across, the often very sectorised, departments within the municipality. The second concern raised in the runtime of the platform, where the legal obligations related to reported issues. As it is now, the municipality is obliged to respond to any request within a given timeframe and deal with it with the official workflow and documentation required of a public governmental institution. It was very clear from both the respondents and from the participants in the project, that a more mature version of the city bug report tool would challenge the existing legal framework for case-work and communication between citizens and municipalities in Denmark. The third issues where related to the quality of the bugs and what level of description that was needed in order for anyone to start addressing an issue. This

is also reflected in the incoming bugs and the diversity of descriptions and the level of detail. While the bug reporting platform prompted both reflections upon and discussion the role of both digital tools, communication and the changing relationship between citizens and municipalities, it also inspired the Citizen Service to work with the concept internally, seek out more information on data visualisation, business intelligence and big data in relation to the area. According to the respondent, they are both working with the idea of an open hearing portal and showing some of their data on the existing urban screens in the city.

The media façade itself did serve its purpose throughout MAB12. However, the animation and content on the façade was very hard to decipher for outsiders to the project. When explaining it to participants at the Biennale, journalists and other outsiders, it was very clear that the content on the media façade failed to make the civic communication and transactions on Postlisten more accessible, transparent or relevant. On the contrary, it was very hard to explain the project and content to outsiders and the media trying to convey the installation on the city hall tower to the public, confusing and mixing up the actual content. In spite of this, the media façade itself generated a lot of stir inside city hall. One of the respondents explained how the combination of real data from Postlisten and the high visibility was taken very serious in city hall and the participants from Citizen Service noted how they where slowly become more conscious of the potential political implications as the project became more concrete. One respondent expressed in the interview, that they started asking themselves what would happen if the project reached the "frontpage" of the local media. According to the same respondent, the installation generated a nervous atmosphere inside city hall, even though the content of the façade was very hard to decipher. Regardless of the nervousness inside city hall, the running time of the media façade got extended to the 3rd of December, due to a visit by the Minister of Housing, Urban and Rural Affairs and a board meeting in the Smart Aarhus initiative.

DISCUSSION: CITY BUG REPORT AND IMPORTANT CONCEPTS

In the following we will discuss the project, City Bug Report, and the outcome in relation to two of the topics that have had a strong significance in our own reflections on the project and stand out, in retrospective, as important concepts.

Designing digital publics

In City Bug Report we ended up designing and exploring two different notions of digital public spaces. The media façade was not a public space in itself, it hardly changed that much on the outside in terms of the urban space around city hall being a public space. But the perception of a public, The Public, in terms of transparency and accountability created a different digital public space. Just as Bentham's panopticon allowed on to gaze at the many, the media façade created the sensation of The Public looking over the shoulders of the municipality. In that sense the media façade became perceived as a different digital interface between the citizens, the public, and the municipality. In reality the the façade never gave real sense of transparency from the outside, as the content was simply to abstract, but the facade acted upon the employes at city hall, just as Bentham's panopticon acts upon the individual in Foucault's famous analysis[17]. Showing what happens on the inside of a building or connecting the inside to the outside via media architecture is not an unfamiliar idea, and how this affects not only the urban space outside but also the inner workings of a public institution is a very interesting perspective to explore further.

The platform on the other hand represents a tool that invite the public to participate. The openness in the categorisation and low requirements in the web form allowed citizens to report what they perceived as "bugged" or broken within their city. Not only did the citizens rather quickly provide rich and detailed descriptions of issues within the build environment, they also used the platform as a way to express their discontent with political decision regarding the school system budget. While we are normally sceptic regarding the saying *build it and they will come*, the bug report platform proved that at times issues and concerns can drive participation. Le Dantec & DeSalvo discusses attachment too and the role of issues in forming publics[24]. Here they draw on Dewey's idea of multiple publics forming around specific problems[11] and relate this to the act of infrastructuring[30]. Le Dantec & DeSalvo argue that infrastructuring *"[...] is the work of creating socio-technical resources that intentionally enable adoption and appropriation beyond the initial scope of the design, a process that might include participants not present during the initial design."* Here, the bug reporting platform both becomes a platform for formation of publics through the ability, not only to raise tame issues, but also because it enables the formation of publics around matters of concern, that is more wicked issues[28]. In the sense of infrastructuring discussed by Le Dantec & DeSalvo, the platform enables participation around *future* issues in the city. The interesting element to us, is the balance between designing a platform that allows the richness, broadness and contested nature of urban issue, but also how important the idea of issues are for both participation and the design of a digital public space. The real challenge is how to keep the open and infrastructuring nature in the platform, while also ensuring enough potential for the municipality. If how bugs are described are to open, general or vague it becomes harder for the municipality to act upon these, while a too narrow description, e.g. via a strict template, would ensure the right level from the perspective of the municipality, albeit remove very aspect that may motivate people to participate around specific issues.

Prototyping what?

We feel like we have targeted city managers and municipal department heads with our installation on the city hall tower. The media façade seem to have a more significant impact on the strategic level and the inside of city hall, than on the citizens and the urban space outside. While we wanted to create something that would get attention on the outside and wanted to increase the transparency from a citizen perspective, our research agenda where to also to explore the digital and strategic maturity of the municipality in Aarhus. We

wanted to prototype or test the current organisational perception of transparency and conception of open data and civic communication, through both the media façade and the bug reporting platform. Through both the discussion in the development phase and subsequently in the reflections afterwards, we have clearly made parts of the municipality consider both the potential and challenges in governmental transparency and open data. More precisely, and partly due to us being unaware on the seriousness involve, the Citizen Service department and other participants from within the municipality now seem to have a deeper understanding on the level of legal, technical and political implications involved in working with the elements involved in the project. Dalsgaard & Halskov[9] describes alignment of stakeholders and transforming social relations as two challenges pertinent to developing media façades. In the context of City Bug Report, we have tried to move beyond alignment and actually tried very actively to push existing perceptions, assumptions and agendas. It is almost given, when you want to expose real data on civic communication within a city, but we wanted to explore some of the implications, changes and unforeseen consequences, in what Dalsgaard and Halskov calls transforming social relations, to actively trying to understand the changing relations between the city and its citizens. Here we see City Bug Report both as a prototype, that is a design suggestion for how future technologies could be appropriated by the municipality, a probe into how the municipality and citizens would use such tools and what types of breakdowns they would elicit and finally a provotype existing assumptions and challenge these with alternatives.

But as the scope and scale of urban interaction design and research changes, what are we the prototyping? The technology, usage, adoption, quality, aesthetics or the usability? We initially presented Fatah Gen. Schieck's [14] call to target the planning system, and argue that we could expand this to start prototyping some of the areas where the policy is inadequate, dated or completely lacking. According to raham and Marvin[19] and Aurigi[2], we should not expect the policy or strategic push for more holistic approaches to come from neither urban planners, city managers, industry or sectorised research areas. Aurigi argues that *"Recombinant space can only be dealt with by a recombined discipline."*[2, p.14], that is from the emergent interdisciplinary and transdisciplinary traditions, such as media architecture and urban interaction design[7]. So maybe we should start urbanising technology[29] and use this as an occasion to start prototyping policy, challenges and implications with the aim of providing insights, not only around the media façade, but also for the strategic level within the city. From our experience with City Bug Report, we know that the policy is needed, the stakeholders want to experiment and we most definitely have some insights that can help develop citizen-centric digital cities.

ACKNOWLEDGMENTS

AHL Media Façade, Media Architecture Institute, Realdania, Municipality of Aarhus, Smart Aarhus, PIT, CAVI

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Community Is the Message: Viewing Networked Public Displays Through McLuhan's Lens of Figure and Ground

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ABSTRACT
Networked public displays are being portrayed as "a new communication medium for the 21st century", potentially having the same impact on society as radio, TV, and the Internet. In order to understand how this new medium can impact the society this paper uses a (small) part of Marshall McLuhan's media theory, i.e., the interplay between the figure - the medium - and the ground - the context in which the medium operates - and how the figure amplifies otherwise invisible effects of the ground. By analyzing environmental/urban research on interactions and processes in public spaces this paper infers the effects of the ground - public space - amplified through the figure - networked public displays - on its audience, showing *why* this new medium is fitted for affecting and enriching place-based communities. Overall, this paper contributes to the theory of networked urban/public displays and their use as a communication medium.

Categories and Subject Descriptors
H.4.3. [**Communications Applications**]: Bulletin boards; H.5.3. [**Group and Organization Interfaces**]: Theory and Models; H.5.1 Multimedia Information Systems;

General Terms
Theory

Keywords
Media theory; Networked public displays; Figure and ground

1. INTRODUCTION
Networked public displays are envisioned as a new and powerful communication medium for the 21st century, with potentially having the same impact on society as radio, TV, or the Internet [6]. This is not hard to imagine as large LCD panels are painting the urban landscape [14] and soon they will be connected over the Internet [6] allowing connections within and between different places. Moreover, researchers are reporting more and more on live test beds used to test the capabilities of this new medium [27, 28]. However, in the real world, outside of academia and beyond the innovative but often short-term work by artists, a vast majority of these displays only show locally stored power points, images and videos, resulting in little attention from their potential audience [26]. In order to fulfill their potential as a communication medium and turn these ignored "ad" displays into something appreciated by its audience, we need to better understand the capabilities and effects such a medium may have on its intended audience.

Intuitively, 'content' seems to play a pivotal role in this understanding, as it is after all the predominance of advertisements that greatly affect (and negatively so) today's attitudes toward public displays [26]. However, recent research [34] revealed that content might not have that much impact on user engagement after all as passers-by are sometimes more interested in 'playing' with a public display and having a shared experience within the group. This points out the relevance of Marshall McLuhan, a pioneer in the development of communications studies and the founder of the media ecology movement, who argued that every medium has a message, regardless of its content [16]. According to McLuhan, the key to understanding the effects of a medium is to understand the interaction between the figure – the medium – and the ground – the context in which it operates – and the way the figure brings into the foreground otherwise invisible effects happening within the ground [17]. Hence, in order to better understand the "message" of the medium – networked public displays – we look into research on processes and interactions in public spaces, with the aim to shed light on how the figure (networked public displays) amplifies the effects of the ground (the public space).

This paper makes a contribution to the theory of networked public displays and their use as a communication medium, in particular motivating work on networked public displays for enriching place-based communities. After discussing related work, we give a brief overview of McLuhan's media theory and the interplay between figure and ground and the "rear-view mirror" analogy. We then describe the ground of networked public displays, i.e., public space, and show what effects networked public displays can amplify. At the same time we also make what McLuhan calls an "inventory of effects" of the figure by giving examples of existing networked public display applications that support identified effects. Next, we present the "rear-view" mirror of the ground/public space and show some of the processes in public spaces that lead to identified effects. Finally, we present concluding remarks showing that community is the message of the networked public displays medium.

2. RELATED WORK
Previous work has explored how we can fit networked public displays with the rest of widespread media such as Facebook, Twitter etc., [22], and how we can build on the properties of public spaces and human needs in them, i.e., the need for passive engagement by observing what others are doing, the need for active engagement by talking to others, and the need of discovery of a place and its new features [20]. Prior work has also looked into situated aspects of single public displays and how we can

ACM 978-1-4503-3302-3/14/11…$15.00
http://dx.doi.org/10.1145/2682884.2682891

design public displays that stimulate social interaction according to Goffman [15]. Our focus here falls closest to Ebsen's work, which connected McLuhan and media architecture, and discussed how a screen can be seen as material for artistic expression [7]. Similarly, McQuire [18] examined the connection between media façades and the city, and how they connect a mediated space between the virtual and the real and impact the actor and spectator role of people in public spaces. More recently and more broadly Foth et al. [8] speculated on new opportunities for pervasive displays and how they would impact our interactions in general. We complement Ebsen's and McQuire's work by contextualizing McLuhan's theory through the reference to communities. We go beyond their notion of a public display as an installation/material situated in a single space, and look at public displays operating across public spaces, creating an intertwined connection between the space and the communities that inhabit it. On the other hand, we have a more focused research question than Foth et al.'s as we focus on networked displays in public/urban spaces.

3. CONNECINTG MCLUHAN, PUBLIC SPACE, AND NETWORKED DISPLAYS

One of the most influential mass media theories that looks into the long-term and societal impacts of media is the one of McLuhan [16] that states "the medium is the message". According to him every medium is an "extension of ourselves" and has a message regardless of its content by impacting the way we interact with each other. In his work he is covering a wide notion of media from, e.g., contentless light bulb that stimulates social interactions by creating spaces that otherwise would not exist in the dark, to radio, TV, and the Internet that stimulated connections within and across space/time creating the notion of "the global village" where people receive news from their locality and distant places equally.

The key to understanding how a medium impacts society lies in understanding the interplay between the "figure", i.e., the medium, and the "ground", i.e., the context in which a medium is used [17]. According to McLuhan, the figure amplifies the invisible and sometimes intangible effects of the ground: "The figure is what appears and the ground is always subliminal. Changes occur in the ground before they occur in the figure. We can project both figure and ground as images of the future using the ground as subplot of subliminal patterns and pressures and effects which actually come before the more or less final figures to which we normally direct our interest." [23] One of his examples of the interplay between the figure and the ground is how the car (as figure) impacted the ground (as ground) and led to creation of suburbs, and connections between the people in suburbs and cities - these are also the messages of the car as a medium. By examining the effects of the ground - public space - on the audience we infer effects that are amplified through the figure - networked public displays - thus putting McLuhan's theory into work. This is in contrast to most of the current examination and understanding of the role of this new medium, which has been mainly focused on the figure, i.e., the screen [6, 8, 28]. In our analysis of the effects of public space we draw from the works that analyzed public spaces in the US [3], UK [4, 12], and internationally [34]. We also go along McLuhan's study of the media by making an "inventory of effects" of the medium/figure and show examples of existing networked public display applications that back up our view.

Our research is using another tool from McLuhan's work: looking through the "rear-view mirror" [16]. The rear-view mirror metaphor states that a medium becomes fully visible only when a new medium has overtaken it. For example, the telephone overtook the telegraph and was first thought of as the "talking telegraph"; or the car that was first thought of as a "horseless carriage". Although the rear-view mirror has usually negative association and its use is seen as "march[ing] backwards into the future" this happens when the role of a new figure is understood through the previous figure - this is how public displays are seen and designed now as *digital signage* that shows similar content as analog signage or poster boards, just in the form of videos and slide shows -- that have little or no connection with the ground/context. However, *we look at the ground through the rear-view mirror* in order to understand some of the causes of people's connections with public spaces and uncover some of the basic principles that we could build this medium upon.

3.1 Figure and Ground

In our analysis of public spaces and the role they have in our lives we uncovered four effects that make them "extensions of ourselves" leading to interactions that go beyond an individual, namely: connecting local communities, promoting community diversity, connecting geographically distributed communities, and enriching local life by connecting it with diverse communities.

Connecting Local Communities Carr et al. [3] explain how public spaces are the building blocks of local communities as they provide the place where local neighbors bump into each other to socialize and share the latest news, help with a heavy grocery bag, or just 'hang out'. These activities, in turn, help in creating the common identity: "When public spaces are successful […] they will increase opportunities to participate in communal activity. […] In the parks, plazas, markets, waterfronts, and natural areas of our cities, people from different cultural groups can come together in a supportive context of mutual enjoyment. As these experiences are repeated, public spaces become vessels to carry positive communal meanings". Today's highly mobile lifestyles make this harder and harder. As explained by Carmona et al. [4] communities of place are still an important part of our lives, but are being replaced by distributed communities of interests: "In a highly mobile age, it is argued that people no longer want or need the previous sense of community and neighbourliness: they can now choose from the entire city (and beyond) for jobs, recreation, friends, shops, entertainment, etc. - and in the process form communities of choice. The issue, though, is not one of an either/or choice between mobility with spatially diffuse contact networks or spatially proximate contact networks. Instead, it is one of providing opportunities for both, and allowing people to find their own balance." In other words, local communities and neighborhoods are equally important as spatially distributed communities of interest that are conveniently one-click away, but are unable to help out sometimes with simple problems, e.g., a tablespoon of sugar when in need [2].

Due their embedded nature networked public displays can promote local connections and interactions within place-based communities. This area of research has received a lot of attention and researchers have stimulated interaction between members of place-based communities by stimulating social interaction through obscure place-based information [20], classifieds and item exchange [1], community's memory and history through photos posted to a display [32], or civic engagement by voting on a locally relevant topic [31]. With a display network a wider area relevant for the community would be covered, e.g., from the local post office to a coffee shop where the local life unfolds as in [32].

Promoting Community Diversity As public spaces are occupied with more than a single community Holland et al. [12] argue that

they should promote the 'provision of difference', i.e., they should be able to cater to the needs of different groups successfully and in a concurrent way, and should not be promoting just social homogeneity. They furthermore state that "being able to be seen in public and to be able to see different types of social groups may go some way to enabling everyone, and children and young people in particular, to observe difference, and thereby perhaps, promote tolerance for social diversity." However, sometimes certain groups do not mix well together, e.g., elderly and teenagers [3, 12], which even results with teenagers moving out from public spaces to "grey" or "slack" areas such as remote hallways or walkways [9]. Carmona et al. point out the benefits of mixed communities in neighborhoods in creating "balanced communities" and state that community diversity provides better opportunities for "lifetime" communities where families and individuals live better within a neighborhood. Thompson [34] explains the need for connecting locally different and diverse communities "Although information technology does allow for a greater flexibility in terms of location, particularly for some office functions, it is also resulting in new urban concentrations for face-to-face activity. People need human contact and the city is the place for that, even if technology allows us to do otherwise if we choose. […] We are thus looking to an urban society where, perhaps, more people are living in relative proximity than ever before, but where the regular daily social contact that comes from sharing homes or living in culturally homogenous districts no longer pertains. It is an intriguing prospect – a close-knit society of strangers."

Networked public displays could promote awareness of community diversity, may it be age difference, cultural, ethnic, or any other. For example, "Pins" [13] explicitly supported expression of different community membership by allowing football fans to show a football club's emblem. Through a display network different communities would get a chance to express their membership in more places/displays thus getting more visibility, e.g., at a University, cafes, public library, or schools as in [13].

Stimulating Greater Connections Within Geographically Distributed Communities Public spaces have the power to connect people across time and distances and stimulate connections that exist in larger society [3]. Such connection "involves an understanding of the meaning of places beyond the superficial level" [3]. Some of these connections are developed due historical events that were carried out at a particular place. In their analysis of public spaces in the US Carr et al. point out several examples, amongst one of them is the example of the Boston Common that captured a tremendous amount of the US nation's history, ranging from being a British camp in the American Revolutionary War in the 18th century to protests in the 20th century against the war in Vietnam. Although not many people can recall all the events that occurred in that space, the space itself emits a beacon of greater historical connections within the people of Boston and the American nation. However, as we reallocate more often our connections with local roots tend to get weaker [12]. Although media such as online social networks offer benefits of long distance connections and increased social capital, recent research pointed out some of the drawbacks in its use as its nature of use is shifting towards self-promotion [29].

Networked public displays can offer aid here by capturing local history and emitting beacons of greater connections within geographically distributed communities, thus connecting them over distance and time. For example, CLIO [30] allowed people to upload stories of historical and local relevance for a place in the city of Oulu or Corfu (2 deployments) in the form of text, pictures, and videos that were shared across a display network. Another example is the Moment Machine [19] that allows passers-by to take photos and share them across the network, thus collecting and creating stories and memories within and across public spaces.

Enriching Local Life Public spaces offer glimpses of connections of our locality with other distant places, e.g., seeing Chinese restaurant can spark and intrigue imagination/day dreaming about a faraway location (unless you are in China), or even broader to faraway galaxies, e.g., standing or looking at Stonehenge can portray our connection with the universe [3]. When it comes to the audience in question, i.e., communities in public spaces, these connections could be stimulated by connecting otherwise distant places and areas. These places do not have to be so far away, but rather diverse from the local. In some cases this could bring up similarities within culturally different communities [24]. In other, e.g., in distant or rural villages, distance from the rest of the world can have negative effects [10], and amongst others, on social interactions in them as public spaces and public life can become too homogenous/concentrated only on the local [3]. Sometimes this sense of isolation is due low diversity in social life of a place and as a result more and more teenagers leave these places once they obtain the legal age (other reasons also influence this decision, e.g., finding a better job or moving to university).

As a communication medium networked public displays could enrich local life by connecting it with (more) diverse places and communities. In this area researchers have mainly used real-time video connection to create connection between distant places, e.g., Hole in Space [11] connected New York and Los Angeles through a video link. Similarly, Screens in the Wild project used a real time video connection in variety of applications [27].

3.2 The Rear-View Mirror of Public Space

In order to stimulate engagement networked public displays can also here leverage on extending and building upon the ground of public space and the way people create connections to it and participate in it. To put it in Carr et al.'s words "Meaningful spaces are those that allow people to make strong connections between the place, their personal lives, and the larger world […] By the build up of overlapping memories of individual and shared experiences, a place becomes sacred to a community […] The freedom to leave a personal mark on a site, one that can rest within marks of history is one kind of valued modification. […] The development of meaning is an interactive process between the space and person that evolves over time, a transactional process in which user and setting are both impacted. […] Repeated direct experience is a requirement for connections to develop." In other words, good spaces are those that go beyond the local and convey connections to "the larger world", allow people to engage in them and create "overlapping memories of individual and shared experiences" or allow them to "leave their mark". This in turn supports the creation of a meaning through "an interactive process between the space and the person" impacting the surrounding, and sometimes greater, community and person's sense of belonging.

There are four important concepts from Carr et al.'s work that describe engagement in public spaces that can be extended through networked public displays. The first involves creating individual or shared experiences through engagement with a public space. If we transfer this to networked public displays this would mean stimulating passers-by individual and shared/group engagement with a display and each other. This can be demonstrated through existing work, for example, through using simple games that allow passers-by to use their whole body [25] or

by stimulating social interaction between them [20]. The second concept involves leaving a personal mark in the setting. For example, this can be as simple as allowing passers-by to express their opinion about the content/topic relevant for the local community using "likes" [21] or contributing to the local history by taking a photo through a display and leaving it on the network [19] or by posting a comment on a locally relevant topic [31]. The third concept involves providing (greater) connections with the (larger) world. Examples of existing work have done this through connecting information from the locality with information from outside of it [21] or through other means like video connections [11, 27]. The fourth, and maybe the most important concept, involves "repeated direct experience" as a requirement for the connections to develop. In other words, in order to stimulate connections through networked public displays passers-by need to have the ability to engage repeatedly over a longer period of time: this is important as it shows the necessity of longer deployments. The above examples show how engagement with the medium can take various forms. Engagement within the local context, e.g., situated engagement with a display and "leaving a mark", may also stimulate the creation of awareness of community diversity, as anyone passing-by can be seen interacting with a display and could leave a mark. This would also allow recording of local history that can be shared across the medium and transmitted to different places, thus moving and signaling connections within a greater community, or infusing diversity into a different one.

4. CONCLUSION

In the core of McLuhan's media theory is that every medium/figure operates within its context/ground amplifying its effects [23]. The above-mentioned effects in public spaces are community oriented and aim at connecting people within and across public spaces. Therefore, the medium "networked public displays" (the figure) within public space (the ground) is a natural/organic fit for stimulating and supporting theses effects, making "*the community"* the message of this medium: Even simply showing community relevant content on a display creates more engagement than showing advertisement [26]. By using the rear-view mirror and examining processes that lead to these effects we contemplate how we can move networked public displays into fulfilling their potential as a communication medium. With our work *we show why this new medium is suited to address and enhance place-based communities*. Also, we hope to start a discussion within the media architecture community, as our view of the medium is very specific and tied to a particular theory.

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Media in Built Environments: The Technologies of Mediatization

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ABSTRACT

Media are becoming constitutive elements of the built environment. From the perspective of mediatization theory, this paper explores the implications of such a claim, with the automobile as an illustrative case, which in turn leads to four observations concerning media and physical space, material and immaterial interfaces, media's simultaneous functions as means of infotainment/interaction/infrastructure and intelligent environments. Together, they point the way to a media-architectural approach.

Categories and Subject Descriptors

H 2.1 Intermedia, H 3.4 Web 2.0, H 4.3 Internet

General Terms

Design, Human Factors, Theory

Keywords

Media-architecture, mediatization, media in the built environment, automobile as media site

INTRODUCTION

Media are leaving behind their long history as discrete devices and dedicated objects like TV sets, record players and telephones. Instead, as currently epitomized by the smartphone, they are becoming highly portable and intensely personal *multi*media whose familiar cross-media differences are nevertheless dissolving – as when a medium reads text aloud or a video clip appears in a textual message. At the same time, and somewhat paradoxically, media are becoming accessible through a multitude of networked non-media objects that are capable of learning, automatically responding to and even anticipating the user (famously, the smarthome and soon the internet of things). Finally, it is not so much media as media functionalities – audio, video, text – that are dispersed and embedded in built environments, creating constitutive ecologies of ubiquitous media that are regularly encountered in wearables, vehicles and physical locations [1].

MAB '14, November 19 - 22 2014, Aarhus, Denmark. Copyright is held by the owner/author(s). Publication rights licensed to ACM.
ACM 978-1-4503-3302-3/14/11…$15.00
http://dx.doi.org/10.1145/2682884.2682893

MEDIA IN CARS

This broad technological transformation is neither science fiction nor speculation about possible futures. It can be observed in a familiar site, the automobile (for a fuller discussion, see [2]). There is no obvious or necessary connection between cars and media. But media have been a persistent feature in cars, beginning in the early twenties, the decade when automobile sales grew explosively. By then, AM radios were being installed in cars. They were very expensive, large and unreliable, with poor sound quality, but manufacturers gave them enticing names like Roamio and the Magic Brain. By the late thirties, car radios were selling in the millions. Families listened to the radio in the car together. Radios grew smaller and were integrated stylishly into the dashboard. Push-button and foot controls became available. After the war, related to the development of high-fidelity audio in the home, to the recorded-music industry and to the increase in FM radio stations, car audio quickly became nearly universal. Automobile phonographs were introduced, along with radios that could be removed and used as portables. Car radio was of course a central feature to sixties youth culture. In the decades afterward, audio options became more numerous: 8-track tape players, audio cassettes, CB radio, improved sound insulation, better and more numerous speakers, compact discs, satellite radio. Powerful audio systems turned cars into rolling loud speakers. And DVD players brought Hollywood film and television programs into the car. One effect was to make it an intensely personalized, private site of mobile media consumption. The twentieth century then, the time of the "automobilization" of society, was equally a period of the steadily increasing presence of ever-more sophisticated media in the car - a dramatic, large-scale instance of the mediatization process, when media technologies become fundamental, unavoidable elements in everyday life, altering patterns of social communication.

Media in cars, however, have gone beyond being a significant means of mobile entertainment. Automobiles are now designed, built and operated with the aid of digital technology. Scores of electronic control units and other digital devices monitor, guide and record the mechanical operations of a car. Some improve safety by over-riding the driver's action in braking, staying in the proper lane, seeing in the dark. The driver can electronically choose drive programs that alter ride quality, steering and engine responsiveness. GPS navigation is a standard feature. A car's operating data can be transmitted automatically to the manufacturer; the car's software is updated and service messages are presented. Smartphones connect to the car and display their content wirelessly on small video screens, enable hands-free phone calls, play the occupants' preferred music. Advanced car models feature numerous interfaces that use increasingly natural ways to control media. Successful experiments in driverless cars

depend on highly developed on-board digital technology. Automobiles today are nearly fully digitalized vehicles and simultaneously sites of mediatized cultural consumption and production.

The mediatization and digitalization of the car, a quite banal, universal means of transportation, illustrate principal themes concerning media in built environments generally: media infiltrate and contribute to the redefinition of space; media interfaces take on a variety of forms that can make them a material part of other objects, though engaging a medium by going "through" its interface is less and less an act of manual or mechanical manipulation; media functionalities blur the line between providing infotainment, acting as interactive means of communication and being essential, immaterial infrastructural components of the environment; media help create environments that learn, respond to and anticipate user behavior, distributing intelligence throughout the material world.

From this perspective, theorizing media architecture demands the conceptualization of a media-architecture - acknowledgement of the growing inseparability of media and constructed spaces and designed objects, most of which are not obviously or primarily "media." This approach, which implies one kind of research agenda, has greater kinship with Le Corbusier's almost century-old admonition that a house is a machine for living in than with more recent attempts to link media and architecture, such as Beatriz Colomina's [3] claim that "modern architecture only becomes modern with its engagement with the media" - by which she means mainly gaining the attention of popular culture (think present-day starchitecture) - or that "the building is a mechanism of representation in its own right." The latter sentiment has guided interesting analyses of old and new media buildings whose exuberant design boldly announces their occupants' self-importance to major urban centers [4]. In contrast is the aesthetic shared by Corbusier's Villa Savoye (1929), Grete Schütte-Lihotsky's 1920s Frankfurt kitchen and Frank Lloyd Wright's 1930s Usonian houses. Influenced by the efficient design of steamships and automobiles, or in a quest to maximize living space within the limits of a tightly constrained place, or to enhance the illusion that brings the outdoors inside or to achieve low cost through the application of industrial practices, these are built environments that integrate the tools of everyday life into their very structure. An open floor plan facilitates the flow of occupants throughout the space, visually and actually, breaking down traditional divisions between the labors of daily existence. Built-in furniture is explicitly tailored to the overall design. Natural light fills what would otherwise be dark or artificially illuminated spaces (see also Walter Gropius's "total architecture" [5]).

The study, design and construction of media-architecture with this sort of sensibility must turn its attention to everyware media, embedded and ubiquitous in an emerging world of continuous interfaces.

MEDIATIZATION

Mediatization labels a body of developing theory that attempts to capture the sheer pervasiveness and fundamental influence of contemporary media [6]. Its proponents make a powerful case. Norm Friesen and Theo Hug [7] argue for the widespread "condition of the mediatic a priori," by which they mean that today media "can be said to structure our awareness of time, shape our attentions and emotions and provide us with the means for forming and expressing thought itself. Media, in slightly different terms, become epistemology: the grounds for knowledge and knowing itself." This comprehensive, ecological quality of media is reiterated by Eric Rothenbuhler, who sees them as "something we live inside as much as they are technologies we use for expression, information, influence and entertainment" [8]. For these reasons and others, media do far "more than mediate in the sense of 'getting in between'," [9] but reshape relations among all social institutions. Scholars view the mediatization process on the same historical scale and with a similar scope of consequences as globalization, urbanization and individualization [10]. As Friedrich Kittler [11] famously wrote, "Media determine our situation."

What Kittler has in mind, however, does not concern the content of media. To the contrary. In his essay "There is No Software," Kittler [12] claims that, "there are good grounds to assume the indispensability and, consequently, the priority of hardware in general." His view is that the technological means of media production, distribution and consumption determine the features of immaterial content and, presumably, strongly influence the nature of its experience – which turns common sense on its head, since while people "listen to the radio," it is music or speech they wish to hear. And it is there where conventional media analysis tends to focus. Nicholas Gane [13] calls Kittler's position "radical post-humanism," and refers to him as a pioneer in "media materialism - an approach that privileges, at all costs, analysis of the material structures of technology over the meanings of these structures and the messages they circulate." (Gane [14] also says that Kittler himself uses the term "information materialism.") As a post-humanist, Kittler [15] judges that the media age "renders indistinguishable what is human and what is machine." This is so partly because information machines "can imitate any other machine, and that includes us, in so far as they can imitate our thinking" [16].

Most mediatization theorizing lacks Kittler's technological emphasis. Instead, the principal debate is between institutionalists and social constructivists. The former [17] argue that mediatization occurs when either formerly non-media activities are absorbed by the media, like online banking (the strong or direct version), or when a social activity grows dependent on the media, as when popular knowledge of a foreign country comes chiefly through Hollywood films (weak or indirect). From this perspective, media share a "logic" – genres, organizational structure, expectations about audiences – that other social actors take on, to greater or lesser degrees, as part of their own functioning (politics is the typical example). Social constructivists look more closely at "small life-worlds" to determine which media are involved in what kind of changes in micro-level communication behavior [18]. Andreas Hepp argues for a common ground between the two schools in determining what he calls the "molding forces" of a given medium in a specified situation. Seeking a synthesis, Hepp [19] begins to appreciate the technological element when he recognizes that media act to "reify" social communication behavior through "technical apparatuses."

Klaus Bruhn Jensen [20] criticizes the general formulation of mediatization theory for neglecting considerations of technology. He makes three points: (1) that digital technological developments have problematized familiar notions of (mass) media; (2) that media are becoming distributed and embedded in "multiple objects and settings"; and (3) that "communication is transgressing boundaries of the physical world, becoming embedded in both the natural environment and the human body." These features may mean, Jensen observes, that digital media will make changes "in radically new ways" and exhibit a pace of innovation and adoption different from their analogue predecessors. It seems clear then that attempts to conceptualize the mediatization process must attend closely to the technologies of emerging new media. Some of that work has actually begun, and with specific implications for a media-architecture.

Media In The Built Environment

Hardware, software; object, content; device, functionality. This bifurcation or tension between the material and the immaterial is an abiding quality of media. It is not surprising then that a recent Pew [21, emphasis added] survey of experts on the future of the internet begins by forecasting both features, "an ambient information environment where accessing the internet will be effortless and most people will tap into it so easily that *it will flow through their lives 'like electricity*.' [The experts] predict mobile, wearable and embedded computing will be *tied together in the internet of things*, allowing people and their surroundings to tap into artificial intelligence – enhanced cloud-based information storage and sharing." The imagery suggests almost magical conditions: intangible, ubiquitous information made accessible through commonplace objects. It is fair to say that in the report as a whole, emphasis is on the former and its consequences (divided, of course, into the "more-hopeful" and "less-hopeful"). Very little is said directly about the things that will constitute the historically new type of media interface.

Quite apart from specific media considerations, there is a substantial body of literature, in anthropology and cognitive science, for example, that clearly establishes the social significance of objects – as in the internet of *things*. Daniel Miller [22] asks, "Can we have a theory of things?" His response asserts the centrality of objects, which, barely noticed, literally frame social life and help shape people's "categorization and appraisal of our circumstances. The less we are aware of artifacts the more powerfully they can determine our expectations by setting the scene and ensuring normative behavior . . ." Moreover, the objects people make – and this certainly bears on media – act like a "distributed mind" [23] and influence others' minds. This thinking immediately elevates the importance of the design and affordances of media objects in a way that the Pew study misses entirely.

Other researchers consider material objects and their relation to embodied cognition. There is evidence, for instance, that the act of handwriting, but not keyboarding, stimulates regions of the brain that contribute to children's learning to read. The manual task of writing a letter appears to make the mental recognition of the letter more successful [24]. Likewise, research shows that understanding abstract number concepts is related to the motor experience of writing numerals or using one's figures to count. There may even be a necessary connection between experiencing an emotion and accurately grasping the meaning of the emotional concept [25]. Raymond Gibbs [26] argues for the significance of "kinesthetic-tactile experience" to conceptions of the self and higher order thinking generally. And there are those like Andy Clark [27] and Katherine Hayles who view humans and their material tools as inextricably interlinked, each fashioning the other. People invent tools and develop the practices of their use, which in turn alter cognition and physical ways of being in the world. Hayles [28] explicitly points to generational differences in reading styles that she ascribes to digital natives' experience with new media. This, she believes, has fostered "hyper-reading," or techniques of scanning, shifting attention and textual sampling, unlike the "deep reading" of older people (she and others see this as an appropriate instance of evolutionary adaptation).

People's relations with media objects can be surprisingly intimate as well. The use of smartphones entails feelings of self-identity and bodily extensions. A familiar sensation is being continually available to others – and expecting others to be available. Their design (brand, color, case, wallpaper, ringtones), choice of apps, frequent handling, storage of music, photos, mail, texts – all deeply personalize the smartphone and make its absence hardly bearable and its loss a crisis [29]. John Urry [30] views the increasing intermingling of people and intelligent environments, replete with emotional, psychological and aesthetic relations, as typical of the new century. It is, he says, "through inhabiting machines that humans will come to 'life'."

These observations return the discussion to the four themes of media in built environments that were derived from the experience of the automobile.

Media And Physical Space

The twentieth-century biography of audio-visual media is one of over-lapping cycles of steady introduction, adoption and replacement. The dynamics behind such waves of innovation are as much corporate and regulatory as strictly technological. AM radio was quickly colonized by commercial networks, FM was delayed by turf battles and a preference to develop television first, recorded music formats (the several analogue discs, reel-to-reel tape, etc.) took complicated decades to reach present-day digital streaming technology. All of this is important, cannot be forgotten and must be held in the background, but is not the principal subject here.

A media-architectural analysis of the automobile would note that cars were originally not intended as media sites, but rapidly became a prime example, and that consumer media began as or quickly became domestic products, but were many of them nevertheless adapted to the automobile. Media in the car were mostly quite different objects from their domestic sisters. An in-dashboard AM/FM radio, a portable radio and a hi-fi receiver/amplifier might have shared transistor technology, but none could be mistaken for the other. A medium like television was immensely popular but took a very long time to find a perhaps limited place in the car. Recorded audio has been a persistent auto medium, but never included reel-to-reel and phonographs, for obvious reasons, were impractical.

These sorts of general observations throw down conceptual and empirical challenges. How, when and to what extent did automobile design take into account the requirements of media? What was the nature of explicit collaboration between the car industry and with what is now called the consumer electronics industry, especially as they both globalized? To what degree were the histories of cars and media distinct or overlapping? For example, while the regular availability of FM radio in cars may have been integral to the sixties, the history of FM technology, regulation, station construction and industry development is so complex that the convergence of the two may have been an historical accident. Do people's lives with media at home create continuities with transportation media, or not? To what extent might consumer demand foster the mediatization of cars compared to the influence of automobile marketing or audience-seeking by media industries? If it can be said in material-cultural terms that media remade the automobile, did automobility contribute to the desire for and acceptance of mobile and dematerializing media?

It is one thing to observe the surprisingly persistent and transformative presence of media-in-cars, and another to account for it. Some of the questions it leads to can be quite particular design matters – about seating, say, and speaker placement – while others are far more complicated – for example, the influence of car audio reproduction capabilities on the composition and recording of popular music. And finally, while the automobile has the empirical advantage of being a very bounded site, it is still possible to ask, just where does automobility stop? There are roads, driveways, garages, advertising/marketing/sponsorship, clothing, posters, models, movies and television shows . . . a car culture, in fact.

Still, it should be apparent that media remade the car and the

experience of automobile travel. This was not intentional in the sense that zoning leads to the construction of specific kinds of neighborhoods. And yet today it is clearly impossible to imagine cars without media. Unless "automobiles" become something else entirely, like some urban smart cars that have no radios.

Material And Immaterial Interfaces

Swiping a plastic card unlocks a door, charges a credit account, allows travel on public transportation. Driving through a toll station on the highway automatically pays the required fee. Touching a smartphone screen affects the heating or cooling at home. Wearing a wristband records and transmits a body's vital signs. Gesturing controls a video game. A vehicle's GPS system gives spoken directional information. These are all examples of natural user interfaces (NUI). Taken more broadly, the idea might also include the inevitable daily encounters with video screens (airports, elevators, bars and restaurants), background music and scrolling text displays, some of which are interactive. Electronic funds transfer (EFT) and monthly auto-pay from one's bank account are related phenomena. The normal, baseline situation of media use – at a desk with keyboard and mouse, in a chair before a television set, standing in place with a corded telephone, one that requires people to conform to the affordance demands of the device, is becoming anomalous.

The NUI experience is growing familiar, but unevenly. People might open their car door electronically, but not the door to their house. Proponents of the Quantified Self movement might obsess over their "data double," but most people are probably unaware of and uninterested in these possibilities. In addition, the expected internet of things (IOT) promises that media functionalities will be accessible through greater numbers of inter-connected non-media objects and sites. The grander conceptual speculation is that media devices per se, and especially those that require distinct, "unnatural" means to operate them, will become uncommon. Together, these observations suggest a period of transition, intermediate technologies, mismatched expectations and conflicting technical standards. If the car is an instance of episodic, semi-planned and even unexpected mediatization, perhaps a more digitally savvy media-architecture can contribute to a less chaotic shift in the nature of media interfaces.

One category of media-architectural challenge is technological compatibility (and obsolescence). No doubt there is at least one home in the world that plays music on vinyl LPs, audiotape cassettes and, in the car, CDs and satellite radio. None of which is compatible, each medium affording a discrete experience, and to hear the same treasured tune across the several media would involve considerable effort. Whether this sort of situation is desirable or sustainable under media conditions of natural user interfaces in an internet of things is questionable.

Infotainment/Interaction/Infrastructure

Kittler [31] says even his own written text "no longer exist(s) in perceivable time and space, but in a computer memory's transistor cells." People get the news in text, audio and video on their smartphone, which also displays their pet's photograph and a stream of microblogs and plays their preferred music – and allows them to make a telephone call. The movement of people through a room may increase the level of light, turn up the air conditioning and alter the tempo of mood music. In each case, "media" are at work. And conceivably in a coordinated way, as when the space detects the presence of a particular person's smartphone, which determines how the indoor environment will respond. Both conceptually and practically, to use "media" to describe all of this activity, some of it happening simultaneously, is a problem. Especially since, as Jensen noted, "media" still carries the connotation of mass media, which imply "broadcast" media (from one to many) in contrast to the point-to-point (tele)communication afforded by the telephone. Now, of course, "media" is a much broader umbrella, gathering the examples like those above.

Because a given built environment will find media acting as sources of information and entertainment, operating as means of social interaction and functioning as electronic infrastructural networks, more than new terminology is required. Basic considerations of media-architecture must be engaged.

Interface design may proceed in an instrumental way from the task at hand or the user's preferred relationship to the functionality. For example, James Katz believes that people may experience small, perhaps handheld devices as appropriate to intimate personal communication, while other kinds of interaction may use other means.[1] This somewhat describes present conditions, when a middle-class home might have a large flat video screen for common viewing along with its residents' personal smartphones and tablets, plus laptop or desktop computers that are used for work. The proliferation of touch screens could soon make each of these devices' interfaces quite similar, though different in size and use. Such a design uniformity has been pioneered successfully by Apple across the iPod, iPad and iPhone and perhaps soon the iWatch, and to a lesser extent the Macintosh, and Apple TV.

This practical approach suggests that interface design must consider the degree of the user's conscious intentionality when using media. Branden Hookway [32] says human-machine interaction possesses a "fluidlikeness," implying a spectrum of users' awareness of the interface itself when he observes, "the interface takes on a seeming transparency as it is worked through, and as its user is enabled through augmentation." Technologically, a new media interface in the built environment could operate simultaneously as a source of information and entertainment, a way of interacting with others and as an immaterial part of the place's infrastructure. But a specific use might dictate the extent of its transparency and the degree of intentionality required for engagement by users. For some purposes – temperature or lighting, say – the interface might be invisible to most occupants, acting automatically. For purposes of what Malcolm McCullough [33] calls the "ambient common," say, presenting news of wide interest, screen or text might be easily visible but without much means of user intervention. Interaction with intimates, following Katz, might require a tactile relationship with something carried on the body.

Hookway [34] speculates that the interface "encounter is an introjection of machinic intelligence into human selfhood, as well as a projection of human intelligence onto the machine." Perhaps media encountered in the physical world will have networked intelligence of a fairly uniform kind. What will vary will be users' awareness, sense of purpose and, consequently, designed means of accessing them.[2]

Intelligent Environments

The prospect of some version of an internet of things or intelligent spaces has had fairly wide currency in popular culture. Steven Spielberg's *Minority Report* (2002), which was informed by well-known information technology experts, including Stewart Brand (*Whole Earth Catalog*, the WELL, Long Now Foundation) Neil

[1] Professor Katz made this comment in response to a question during a Skype visit to my seminar on Media in the Built Environment, 26 March 2014.

[2] This thought could be pursued according to the terms of the theory of distributed cognition [35].

Gershenfeld (MIT physicist), Jaron Lanier (virtual reality) and William Mitchell (MIT architecture dean), continues to be appreciated for its scientific prescience, while earning more than $200 million in profit. The recent film *Her* (2014), according to one writer [36], is anti-*Minority Report* in the sense that the future it conjures is only subtly different from the present (*Minority Report* is set in 2054) - though its computers lack keyboards, instead using a speech-recognition interface. The story revolves around artificial intelligence so smart that it guides the emotional life of the main characters. *Her* was a critical but not, apparently, a commercial success. These films, and many other examples, have laid the imaginative groundwork for the mediatization of everyday life.[3] And yet, like much else under discussion here, the future is not yet born.

The notion of intelligent environments sums up much of what has been discussed here. As a particular construct, it has an extensive literature. This includes a recent "manifesto" that lays out the field in some detail [39], government studies that imagine ambient intelligence "scenarios" [40], technical instructions for deploying intelligent environments [41], academic programs [42], regular international conferences and special symposia [43].

These are mostly engineering-heavy approaches that can inform but are certainly not the same as a media-architectural approach. This leaves an opening for expanding the scope of analysis along the lines suggested in this paper.

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Over the Rainbow: Information Design for Low-Resolution Urban Displays

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ABSTRACT
To what extent can information be successfully communicated through a media façade and what are the relevant parameters? In this paper, we focus on the issue of information design for media façades, which is not often discussed separately. As a thought experiment, we propose homing in on this topic as a core domain for the deployment of low-resolution, ambient displays in the city. We discuss the advantages and limitations of five techniques for encoding information: color, movement, text, images, and shape. Though designers may not always be aiming to convey explicit information, onlookers may still seek additional layers of meaning and end-users may re-appropriate an infrastructure over time. Two examples from our recent practice, a series of single-pixel way-finding beacons and a low-resolution media façade, serve to illustrate these techniques. By linking the broad notions of 'content' and 'meaning' to a set of purpose-driven and actionable parameters, we invite designers to scrutinize the low-level communication processes facilitated by media architecture.

Categories and Subject Descriptors
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Design, Human Factors

Keywords
media architecture, information design, media facades, resolution, urban displays, ubiquitous computing

1. Introduction
The New York Times electric Zipper, installed in 1928, was one of the first examples of media architecture to explore communication with kinetic text on a low-resolution dot matrix display. Referred to as the "talking sign" for its moving text, information had to be appropriately chunked and scaled for its dimensions. Completed just in time to announce Herbert Hoover's victory over Al Smith, it conveyed political information, which needed to be accurate. At the time, this was no small accomplishment. A team of specialists first translated Morse code headlines and passed them on to trained technicians who loaded the results onto the matrix of pixels [29].

In the early 20th century, simply displaying a few dynamic pixels was a significant accomplishment. As we experience a new wave of media, one of the biggest challenges for urban screens remains the development and selection of appropriate content [15]. When a media architecture project first comes online it often displays a well-known pattern – a standard rainbow gradient, the equivalent of "*lorem ipsum*" for media façades, signaling "our display works, more content to come," but frequently these future applications are challenging to develop and maintain. We suspect that there are also deeper reasons why it is so difficult to communicate information through media architecture.

Conveying information is not always the aim of media architecture. Instead, dynamic and responsive light elements might improve the experience of an urban environment on other levels. Very often, however, clients and designers have the ambition to inform as well as delight. A viewer's curiosity may lead her to interpret the abstract visual patterns of a media façade even if they do not carry a deeper meaning. In the context of civic media, the importance of conveying a relevant and value-added message may also play a key role.

Beyond the aesthetic ambitions of media architecture, a growing body of work has focused on interaction and public engagement with urban screens [31][9][8]. The goal to reach people in their daily routines in public space is closely connected to the claim that ubiquitous computing as technology and interactive interfaces have become deeply integrated with everyday activities and practices [39].

Translating many ubiquitous computing claims to cities is challenging due to the sheer complexity of urban spaces. Many urban display applications, especially if they involve interactivity, are based on the implicit assumption that viewers engaged with the display are actually able to comprehend the designers' intentions; in other words, that communication through media architecture alone actually works. We suspect that this assumption cannot be taken for granted. Consequently, this paper asks a rather fundamental, basic question: What are the conditions and obstacles for information to be successfully communicated through an urban screen? How much and what aspects of information do people grasp? Are there low-level design strategies that can be successfully employed to facilitate the interpretation?

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ACM 978-1-4503-3302-3/14/11…$15.00
http://dx.doi.org/10.1145/2682884.2682893

In this paper, we call attention to the role of information design for media architecture. Using recent examples, we investigate its relevant parameters including scale, resolution, situation, and discuss its constraints and limitations.

2. Background

Urban displays exist on different scales. In our investigation, we focus on large scale displays and installations typically integrated with a building's façade and viewed from a distance as well as distributed infrastructures, such as waypoints. This scale is challenging in terms of information design due to limitations of resolution and a constrained view. The viewer cannot easily change her position with respect to the display or installation, which may diminish the potential advantages that spatiality and contextualization offer to designers. In terms of information design, the smaller scale of urban screens situated in public space [35] is less problematic, since these displays facilitate a closer engagement and interaction with the viewer. At this scale, established information design patterns from interactive media installations or web contexts can be more readily applied.

Situating data visualizations in the physical environment offers interesting design opportunities for establishing a context for interpretation [16, 36]. Dalsgaard and Halskov identify eight challenges associated with media facades [3]. These include technical issues such as the need for new interfaces, challenges of physical integration, stability, as well as social issues, including the need for aligning stakeholder interest, the response to diverse situational contexts, disruption of social practices and re-appropriation. The authors situate the challenge of developing suitable content between technical and human issues, focusing on questions of complexity and the need for explanation. It might be tempting to summarize information design as a sub-category of content, but we would argue against this view, since the fundamental capacity of a display to communicate information has consequences for all other identified issues and needs to be considered as a prerequisite. A critical examination of recent large-scale media façades reveals the central role of contextual factors for the success of the project [17].

3. Information density

Edward Tufte's mantra "*above all, show the data*" emphasizes high information density (for quantitative information) as the most important quality of an information visualization [33]. Maximizing the "*data to ink ratio"* also means removing all elements that do not represent data points. It may be doubtful that this principle can be directly translated into a "*data to lumen*" ratio for media façades. While not undisputed, Tufte's minimalism relies on the well-established visual language used in print and screen formats. Most information displays are embedded in other media formats, which establish a context for decoding the representation. For the viewer in urban space, such a semantic context is absent.

Closely associated with information density is Tufte's postulation that excellent information graphics should be readable at both the micro and macro level. Since the viewer of a media façade cannot easily switch between detailed and global observation, this principle is of limited use in urban space. With his preference for high-fidelity media formats, however, Tufte's principles highlight a sore spot of media façades - the issues of resolution and annotation.

Visually encoded information never speaks for itself – legends, labels, titles, and other explicit textual annotations are essential to make sure the message of a chart, map, or diagram is understood. In urban space, the use of textual explanations is problematic, since, for practical reasons, they have to be spatially separated from the display, often leaving the use of contextual hints the only option. The capacity of the viewer to decode contextual hints is however further limited by distance and attention of the viewer, the overall information saturation of the surrounding environment [12], and the limited resolution and legibility of urban displays. These make it difficult and sometimes awkward to provide clues for interpretation.

This issue can be illustrated by a Pittsburgh landmark, the Gulf tower, which has displayed a weather forecast through a beacon of blue and red lights on its top floors for many decades until the late 1970s. Its scheme was simple enough to become part of local knowledge – orange lights meant fair weather, blue meant rain. Steady light meant rising temperature, flashing light meant falling.

Recently the display has been re-invented by the lighting designers Cindy Limauro and Chris Popowich, who devised a more complex lighting scheme than the original display. Each level of the multi-tiered, pyramid-shaped building crown now presents a different detail about the weather. Temperature is shown in a spectrum of color. Precipitation is shown in shades of purple. Green and pink are used to communicate humidity and wind speed [11]. To make locals familiar with the new code, explanations have been widely published in local newspapers (Figure 1) and a complementary mobile app developed. Whether the new color scheme will become part of the local knowledge of Pittsburgh residents remains to be seen.

Figure 1. Legend for the color coding of the weather beacon on the Gulf Tower in Pittsburgh. © Pittsburgh Post-Gazette, 2014, all rights reserved. Reprinted with permission.

3.1 Content follows resolution – options and coping strategies

Typically, media facades are limited in terms of resolution. From an architectural point of view, this is not necessarily a problem. A project such as *Blinkenlights* [22] appeals to viewers precisely because of the architectural quality of its low-resolution pixels, which become a discrete design element. From the perspective of information design, it is a different story. Low resolution severely limits the capacity of a display to convey information. The resolution of a media facade therefore determines the range of content possible, the choice of visual language and the interaction with the user. Theoretically, a wide array of visual and sonic variables can be used to encode information. For information design and cartography, Jaques Bertin offered seven variables including position, size, shape, value, color, orientation, and texture [1]. In the following section, we discuss the main options that apply for media façades as a function of resolution as a function of the number, spatial arrangement, and density of visual elements.

Table 1. Overview of the resolution by content taxonomy

Resolution	Encoding	Meaning
Very low	Information as color	Implicit
Low	Information as movement	Implicit
Medium / low	Information as text	Explicit
High	Information as image	Explicit
Low rel. to scale	Information as architecture	Implicit

3.1.1 Encoding information in color

For the lowest resolution, we find displays that consist of a small number of individual pixels, sometimes as few as one. This is the realm of the ambient display, in which information is encoded using color as a visual variable [41][34]. In an effort to avoid unnecessary distractions and provide a so-called "calm technology" [40], ambient displays are designed for our peripheral attention, assuming that relevant information will still be recognized based on unusual patterns in the reduced visual vocabulary of the display. To make sense of the display, the viewer has to know the symbolic meaning of individual colors. In some cases, an intuitive connection can be made, such as in ambient weather displays on buildings that encode temperature as a gradient from cold to warm colors [4].

The arbitrariness of the visual encoding is the greatest limitation of ambient displays - what counts is what is understood by the viewer, not the intent of the designer. In this respect, ambient displays are not always effective for communicating actionable information [28]. The designer of an ambient display has to consider how additional information can be provided to support the reading of the display. The strategies for the dissemination of these clues have to be considered as part of the design. Users of personal ambient devices typically choose their own information mapping [21]. On the urban scale, the options for personalization are limited, but can be approximated through interactivity.

3.1.2 Encoding information in movement

A second option for very low resolution is to encode information in the temporal behavior of visual elements, their rhythm and movement. Urban space is abundant with temporal displays that structure the day, from church bells to traffic lights. For very low-resolution matrix displays, a high temporal resolution (frame rate) can compensate for a lack of pixel density. Within a certain velocity range, the motion of a visual target is integrated by the visual system, increasing the perceived resolution — a phenomenon known as visual hyperacuity [7]. Diffusor elements or other architectural elements can also help to increase the perceived resolution. The artist Jim Campbell systematically explored the interplay of perceived spatial resolution, diffusion and movement in his figurative low-resolution work series. Especially his *Running and Falling Series* demonstrates how motion can help to recognize the movement of a human figure even on an ultra-low resolution display of 8 x 6 LED pixels [24].

3.1.3 Encoding information as text

On the medium-resolution scale we find the classic moving text display, comprised of letters and simple iconography. Textual displays are ubiquitous in urban space and have been around long before terms such as *ambient media* have entered our vocabulary. Since information is explicit and follows common conventions, textual displays are less hampered by problems of explanation and interpretation. However, the problem of bandwidth remains. Font size, viewer distance, reading speed, and time create a limit to what can be said. While individual words might be recognized in an instance, text requires time to decode. The informational bandwidth can be extended by integrating simple Informational elements such as barcharts or sparklines into predominantly textual displays [32]. Space-filling visualizations such as treemaps utilize every pixel [10].

Text is the natural medium of choice for many participatory projects with contributed content. The London Bus Tops project installed 20 dot-matrix displays on the roofs of bus stops across the city. Citizens and invited artists created custom artworks for the roof. Though not a requirement of the project, most contributors have chosen text as a medium – handwritten or digital – to communicate a message to onlookers.

Text in urban space is frequently paired with contextual references, just as every street sign refers to a specific location. By emulating a traditional signpost, the product *Pointssign* uses scrolling black-and-white text o a hinged element that can point in any direction, conveying contextual information about local events and sites [20].

3.1.4 Encoding information in images

At the high-end of display resolution, urban displays frequently share many characteristics of the billboard. They use pictorial media content, abstract shapes, photos, and videos. The outdoor advertising industry has done a lot of research regarding the effectiveness of visual languages in urban space. For example, legibility at distances of up to 1000 feet demands large fonts with heavy weights and ample spacing. Text should be minimized to seven words or less [19]. The number of colors and visual elements should be minimized, the composition should consider gestalt laws, follow a clear hierarchy, and avoid clutter [30]. All these requirements limit the amount of explicit information that can be communicated. Color choices depend not only on the perceptual, pre-attentive effects of visual elements within the display, but also on the urban situation around the display and distance effects such as color perspective. The perception of shapes and images is both a function of viewing distance and resolution; being too close can make a display illegible as well. As the hybrid image illusion illustrates, different spatial frequencies

can lead to the perception of two different images depending on the distance of the viewer [25].

The display integrated into the WGBH public broadcasting station in Boston provides an interesting case study for information design issues of billboard-like displays integrated at the architectural scale [5]. The display is a rectangular LED matrix well integrated into the architectural form of the building, occupying one end of a horizontal, elevated building element, and dissolving into vertical stripes with increasing distance towards the other end of the element. Notably, the display is poorly visible from the adjacent streets; its effect is intended for viewers passing by on a nearby freeway.

Chris Pullman, Vice President of Design at WGBH, commented on the development of the visual language for the display. The original plan of using the screen for program announcements was complicated by the fact that reading does not mix well with the activity of driving. After testing the display, the messages became shorter and shorter until the designers decided to remove them altogether and began to rely entirely on high-quality images. Movement and animation was another challenge. Security concerns made it clear that fast movements and cuts cannot be used, but slow, horizontal or vertical pans were not a problem and could even improve the perceived resolution of the images.

Figure 2. Digital Mural of the WBGH headquarters in Boston. Source: Wikimedia Commons

This ties back to what Robert Venturi and Denise Scott Brown described fifty years earlier - the speed and distance of the observer dictates the appropriate communication strategy for urban displays and becomes a determining factor for the urban landscape [37].

3.1.5 Encoding information in the shape of the building.

Robert Venturi and Denise Scott Brown's famous dichotomy of the vernacular semiotics of the Las Vegas Strip, the *duck* and the *decorated shed*, still resonates with today's media architecture. Urban displays are either deployed as screens attached to otherwise ordinary buildings (decorated sheds) or more extravagantly, as the sculptural surface of the building itself — analogous to walk-in fiberglass duck on Long Island where the sign and the architecture had become synonymous.

In a more recent text, Venturi addresses this analogy and reviews many examples of what he calls "explicit mannerism," including two buildings in Times Square: the Morgan Stanley building on Broadway between 49th and 50th and the Morgan Stanley Dean Witter building on Seventh Ave. and 50th Street, both designed by KPF. "Viva the façade as computer screen! Viva façades not reflecting light, but emanating light - the building as a digital sparkling source of information, not as an abstract glowing source of light!" [38]. Venturi touts the vibrant ornamentation and dynamism these buildings contribute to public space. The architecture itself blends into the background while the sign and the dynamic programming are positioned in full view.

From a design perspective, the fusion of architecture and display can be highly successful, but from it raises an interesting problem from the content perspective. The building becomes part of the message. Regardless of how flexible its pixel can be programmed, the architecture shapes the viewers' interpretations. Nevertheless, context is always present even in de-contextualized text displays. Consider, for example, Jenny Holzer's public artwork "Truisms," which features short, reflective textual statements on urban information displays [23]. While Holzer explicitly disregards the design of the display, the resulting aesthetic effect does rely on the apparent contrast between the personal nature of the statements and the publicness and banality of the display medium.

4. Two Case Studies

Two examples from our recent work address the issues of low-resolution and explore potentials for communicating explicitly in public settings. The first is an extremely low-resolution display – a single pixel – designed to reinforce wayfinding information. The second is a low-resolution 18x50 pixel media façade used for ad-hoc community surveys.

4.1 Example 1 –Wayfinding information with single-pixel light beacons

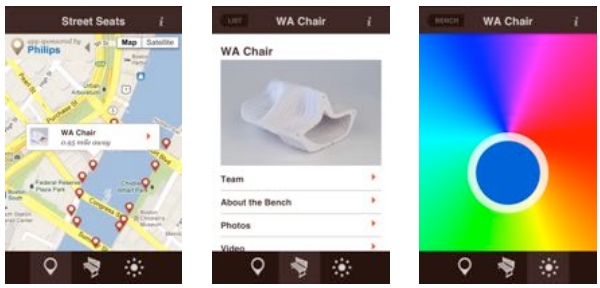

Figure 3. An interactive web application providing a map interface for locating the exhibits of public seating exhibition, detail pages for each exhibit as well as an interactive page for assigning colors to each pixel. The map interface changes colors according to current state of each pixel. The app is restricted to users within a 0.5 mile radius.

The Street Seats Beacons were a temporary platform for exploring potentials to enliven public spaces in everyday city life. Design Museum Boston installed 18 award-winning designer benches in a half-mile radius in downtown Boston. An interactive light beacon accompanied each bench, marking the location of the exhibit. Citizens were able to use a mobile web app to navigate through the exhibition, learn more about each bench and change the color of each beacon. The web app could be directly accessed via link and QR code at each exhibit. In this case, no explanation or instruction was given about the color-changing capacity or about

its purpose to achieve its goal of providing a system that could be discovered. An evaluation was conducted to investigate how people would perceive this function and how they would use it to assign meaning to this low-resolution display.

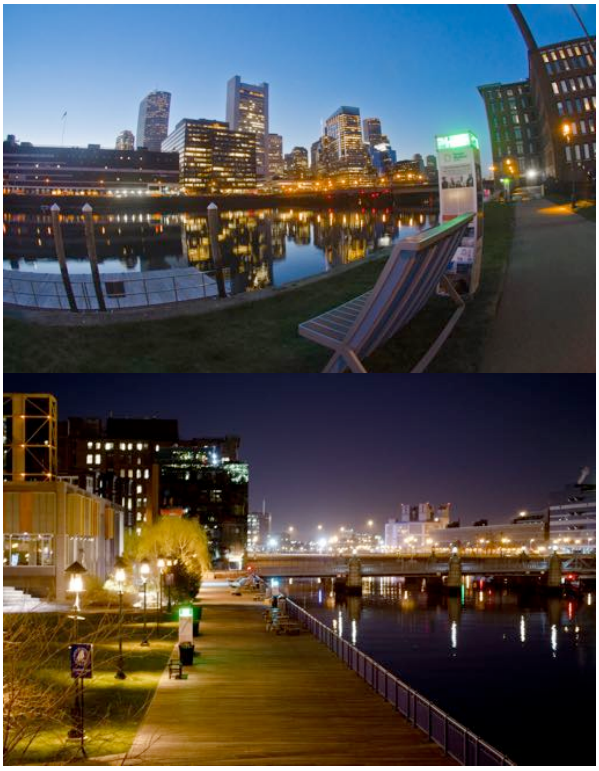

Figure 6. Top: Beacon and bench close up. Bottom: view of the Children's Museum dock in Boston showing several beacons. Photos by Garrick Dixon.

We conducted a qualitative survey (n=88) between August 19 and September 2, 2013; responses were coded and tallied with respect to the perceived purpose of the beacons.[1] The following figure quantifies responses to the lighting elements, which shows that the unspecified purpose did not deter users from enjoying the platform.

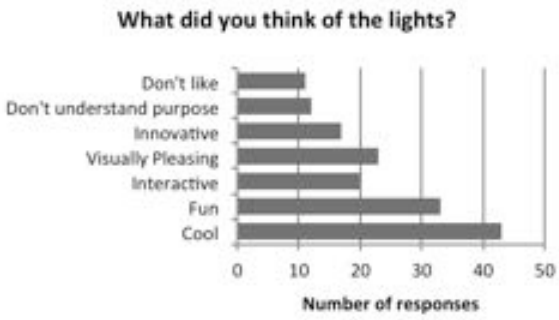

Figure 2 Categories summarizing visitors' interpretations of the beacons' meaning.

More revealing were the free-form comments offered by the respondents indicating the range of interpretations resulting from parsing the purpose of the system. People particularly enjoyed the interaction aspect, one respondent noting: "A true discovery. But not truly inviting immediately after a heavy rain! But I will come back with my smartphone in drier weather!" Interaction was facilitated by the simple design of the software. Children were especially enamored with the system and some users reported having to return repeatedly over the 6-month installation time to engage with the system. Most people commented on ease of use: "Appreciated not having to download an app", "could change color the beacon so easily". Compared to manipulating the color, users had more difficulties with accessing the textual information on the seats; some "found it hard to find despite the QR code" referring to the QR codes located underneath the beacons. Questions also arose on how the system supports multiple users, revealing expectations that the individual beacons were linked, when in fact they were independent. Disappointments resulted mostly from the web app not working on a phone for whatever reason — a type of challenge shared with most ubiquitous computing systems.

In addition to the survey data, we analyzed the web application usage patterns with information collected using Parse and Google Analytics. During six months of operations (April-October 2013), 1,742 people visited the web app and spent a remarkable 4 minutes and 24 seconds on average using it. Sixty-one percent of total users used a mobile phone to access the app and approximately half of users took advantage of the controls interface. The following diagram shows the colors selected by users. The distribution of chosen colors is surprisingly even, with exception of purple, which may be linked to the global Breast Cancer Awareness month taking place during the time of study.

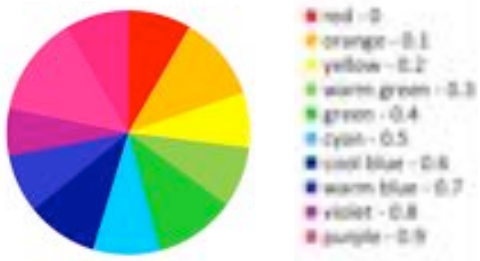

Figure 5. Colors selected by users

[1] Data were collected by Kevin Edelson, Liam O'Kennedy, Delaney Rebernik, Susanne Seitinger, and Lauren Spinella

The Street Seats Beacons project foregrounds playful interaction over information delivery. The deliberate absence of instructions led some users to search for hints what the colors should signify. However, by assigning colors they were able to mark a place and therefore construct meaning. The simultaneous feedback mechanism using the map interface that gives a global picture of all beacon colors may have helped clarifying this point. The simplicity of the project matches the affordances of the low-resolution display and was appropriate, since visitors had no trouble connecting to the system.

4.2 Example 2 – Ad-hoc campus surveys with dotvot.es

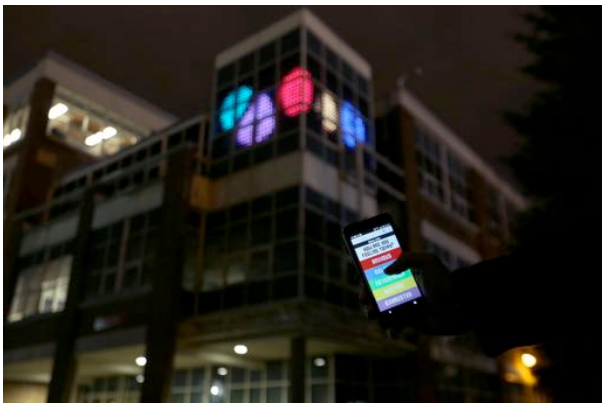

Figure 7. Separation of annotation and display. The URL http://dotvot.es is periodically displayed as running text on the façade, and placed stickers in the preferred viewpoints of the display. Photo by Maria Amasanti.

Figure 8. The bar chart comparing the individual votes.

The second example is a transparent media façade developed in a design studio course on the campus of Northeastern University. The screen was built by the class from individual LED elements arranged in a transparent grid of 48”x18” mounted behind a glass façade in the corner of a studio classroom. The starting point for the class was an exploration of information density on media façades , inspired by Marshall McLuhan’s dichotomy of hot and cold media, in which hot refers to high information density, low redundancy, and a high level of explicit information, requiring high concentration and attention [13]. Which qualities make an urban display “hot” or “cold,” respectively?

Initial tests of the installed media façade disappointed the expectations of some students. While the restrictions of resolution were clear from the onset, the relatively large gap between the individual pixels made it difficult to recognize coherent images, even when specifically designed for the display’s low resolution. Photographic images were not recognizable with the naked eye, but turned out surprisingly well on photographs of the façade, which led us to experiment with the idea of requiring a smartphone camera to decode the display. Certain images were recognizable from far away, but not from a closer distance. Text recognition was a borderline case – the 6x6 pixels of each window could comfortably fit one character (each façade side consists of 4x3 windows). A line of text had to occupy at least the third of the display’s height in order to be legible. Slow movement seemed to improve text legibility.

After several iterative rounds of individual and collective brainstorming, including the consideration of frosting the windows and other measures to help create a more coherent image, the students decided on a strategy where each individual pixel was treated as a discrete piece of information — a vote, a discrete interaction by a user. Since the opening of the installation was scheduled for final exam period, the team elected to poll the campus about its mood. A web application as well as physical interfaces allowed students to choose among five states [6] and cast a vote, which would instantaneously emerge from the corner of the façade. A physical simulation ensured that votes would aggregate and cluster, while remaining recognizable as individual elements.

To facilitate communication, a two-minute sequence was programmed featuring textual explanations of each state and a bar chart with the percentage of votes cast. Ad-hoc interviews with viewers revealed that animation was essential for the display to be interpreted as real-time information. As a user cast her vote, a small shape entered the display from randomly assigned sides to join the larger cluster for that emotional state. Not only did this movement reinforce people’s understanding of the interaction, it also reinforced the frameless nature of the display. It’s implied that there is another canvas beyond the pixel matrix on the building. The clusters rhythmically pulsed at different frequencies were driven by a metaphor one of the students explored throughout the whole semester around the nature of breath as a proxy for bodily tension. The *anxious* cluster would for example pulse more quickly than the cluster representing *exhausted*. Each cluster is shown individually and in conjunction with the others.

The central concern of helping the viewer to read the display was addressed via multiple and redundant channels. The running text on the façade would start with the question “How do you feel?” followed by the URL dotvot.es. The meaning of each cluster was introduced individually. Towards the end of the cycle, the pulsing clusters would re-arrange themselves into bar charts, facilitating direct comparison. The URL would take the user to a mobile website offering voting options, and providing an animated user-guide explaining the functionality. In addition, stickers with the URL and a brief explanation were attached around campus, and finally physical voting buttons were available outside the display.

Although these measures were largely successful, the responses of pedestrians revealed the dilemma between data display and explanation: the moving text was effective communicating the intention of the installation, but distracted from the more subtle cluster visualizations – after reading the text, some viewers assumed that all information was communicated in textual form.

5. Conclusion – Lessons for information design

Meaning is always a contextual and open-ended affair, but especially so in an urban environment, with its plethora of signals, information channels, and layers of information [26]. Despite, or precisely, because of this richness of meaning, it is challenging to communicate information in urban space in a purposeful way.

We do not argue that the media architecture *should* communicate information, nor do we argue for either contextual or explicit modes of communication. Some of the most successful displays are deliberately elusive – suggesting meaning without making this meaning explicit. Interactive applications may create rich representations that are entirely a product of the users behavior, and can be recognized as such with the appropriate feedback.

We do however argue that a freely programmable display is not a blank canvas. Even without considering the context of the display, the technical fundamentals do not only have consequences for choices of content, but also for the communication modality. If communication is the intention, the appropriate information design strategies depend on the resolution of the display.

The intention of this paper is to link different approaches to the design of media architecture content through the single variable of resolution. Each of the discussed modalities — ambient, explicit or contextual, using color, movement, text, image and shape as a visual variable — necessitate fundamentally different approaches for communicating information. The transitions between these modalities along the resolution spectrum are not always continuous, especially on the low end of the scale.

The two case studies offer opposite approaches to the nexus of resolution and information. The beacons, located at the lowest end of the resolution spectrum, deliberately omit explanation and do not intend to communicate any external sources of information. One could argue, however, that they do truthfully and accurately represent the information assigned to them by the users — marks in the city and on the mobile map. Their rate of change mirrors the engagement of the users, and can be decoded as such. They would fail, if expected to convey information that is not a direct result of their interaction with the users.

The low-resolution media façade at NEU represented the genuine attempt to convey arbitrary information and explore its implications for information design. Its resolution is at the critical boundary between the states and modalities discussed. It is higher than necessary for a purely ambient treatment, just (but not quite) enough for textual representations and rudimentary diagrams, but not enough for images — as a result of the large spacing between individual pixels. At this scale, we had the opportunity to explore various tricks to maximize information density such as using movement to increase perceived resolution.

As a consequence of resolution and different representational strategies we arrive at a practical notion of information bandwidth, which includes various tradeoffs: the amount of information that can be represented by the real estate of the screen, the explicitness of the information and the necessity of annotation and explanation. Text is explicit, but is low in information density. Arbitrary visual encodings and space-filling visualization algorithms maximize information density but are hard to decode. In short, text is a problem, but so is the lack of explanation.

One possible solution to the dilemmas of resolution and bandwidth is the clear physical separation of annotation and information. On the building itself, this can be accomplished by using static elements for annotation to complement the dynamic data display, as in the example of the National Debt Clock [18]. Without much explicit information, interactivity can provide a way to explore the functionality of the display. Other communication channels, spatial and non-spatial, can be used, including panels in prominent viewing locations or simply relying on word of mouth. Such as in the case of the Gulf Tower's weather beacon, which has been a landmark for decades and whose complex color coding of the weather forecast is frequently featured in the media [2]. In both case studies, the mobile interface was chosen as an annotation layer, which offers flexibility and enables interactivity, but creates an accessibility problem. First by excluding users who do not have a smartphone, and second by not solving the problem of notifying the user about the role of the smart-phone interface. This dilemma requires another means of annotation.

This paper scrutinizes selected examples of media architecture from the perspective of information design. As more mediated elements permeate our landscape we argue for more investigations along these lines. Information and media designer Sebastian Oschatz (Meso), refers to content development strategies as the *third pillar of media architecture next to architecture and media technology* [14]. As a designer himself, Oschatz focuses on the role of the creative designer or curator.

No discussion of urban displays is complete without the role of the viewer. Though implicit in the various interactive examples, the viewer is not explicitly mentioned throughout our exploration. In our investigation, we focused on the intrinsic parameters and qualities of a display, and their implications for information design because we think that this aspect has not received enough attention. However, we are aware of the important role held by the viewer's agency or point of view in constructing that information. As Malcolm McCullough puts it, "How to put value on intrinsic information?" [12]. As in any communication process, the medium is never neutral. Its intrinsic qualities facilitate, shape, but also constrain how meaning is constructed.

Acknowledgments

Students of the MFA program in Information Design and Visualization: Rania Masri, Lauren McCafferty, Esat Karaman, Ashley Treni, Vivian Sung, Miriam Zisook, Zachary Fox, Gadi Baron (all NEU), Peter Schmitt, Philips Color Kinetics John Warwick, Zhou Ethier, Drew Lynch.

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Aesthetics of Urban Media Façades

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ABSTRACT
This paper sets out to develop and extend current literature on design practices for ambient media façades. It does this by bringing together theories of ambient media, computational aesthetics, and urban aesthetics. This unique theoretical combination has informed the design of several exemplars produced by the author, which are discussed as case studies.

Categories and Subject Descriptors
H5.m [Information interfaces and presentation]. J.5 [Arts and Humanities]: Architecture

General Terms
Design, Experimentation, Aesthetics

Keywords
Media façades; Urban Screens; Ambient Media; Design methods.

1. INTRODUCTION
Urban media façades and displays are becoming increasingly common as a result of developments in lighting technology - particularly the rapid advances in LEDs and associated control systems. Images of urban centers around the world testify to this transformation, with "screens" appearing on all manner of surfaces replacing other visual forms. In the rush to create new "applications" designers and developers often remediate previous media forms [5] and conceptual approaches to image in urban space. Such an approach is not necessarily sensitive to concerns of people, place, architecture or urban design, suggesting the need for new understandings of these designed objects, and the way they shape our experience of built and urban environments.

This paper aims to explore the aesthetics of media façades and urban displays by focusing on examples that employ real time data sources, computational processes, interaction, and draw together natural and social systems. At a time when fixed architectural forms are becoming structures and channels for the communication and presentation of "ambient" information it is particularly important to consider the phenomenological experience of televisual screens. Dunne describes screens as "super-matter: once switched on, all attention turns to them, and their material qualities are demoted to status of packaging or container as the viewer searches for real content, information." [10]. Screens give space an orientation through the way they demand visual attention, and configure relationships between image, viewer and space. Media façades conceptualized as screens in this manner very often subsume, or erase, the surfaces and landscapes that they occlude through their placement. They compete for human attention by bringing into our perceptual field the otherwise invisible information environment that forms a background to urban life. This is exacerbated by the drive towards screen-based advertising content as one of the more lucrative ways to produce a return on the upfront investment in the underpinning technology.

Such concerns are echoed in the literature, for example Hausler, Tomitsch and Tscherteu's [18] global survey begins by outlining the challenges presented by the "Times-Square Effect" – which sees architectural surfaces "dematerialized" by the very screens that they physically support. McCullough argues that despite the possibilities presented by new technology, media façades are mostly conceptualised as billboards, through the "frames for other genres of visual communication, and [as a result] seldom as genuine extensions of architecture" [25]. This paper addresses these concerns by focusing on ambient media façades and architectures that incorporate controllable lighting as part of an architectural form, and are conceptualised in ways that differ from previous visual genres.

Rapid developments in technology have allowed designers, artists and architects to integrate lighting into architectural forms in more seamless ways. This integration has led to the screen (typically considered as a rectilinear 2D plane) being transformed into a variety of 3 dimensional surfaces and shapes – becoming part of a building envelope or skin. As a result, light emitting elements (or pixels) have been freed from the regular grid of the screen. Instead they can be placed in respect to the formal qualities of architectural structures and surfaces. This allows designers to focus on the interplay of light and surface, to create unique visual results where screen image does necessarily occlude architecture or landscape. This approach to, van Berkel suggests, will lead to a new "architectural visual language that can surpass advertising and create a homogenous cultural effect" [1].

However, such a new visual language cannot simply be "architectural", as the term is commonly understood. The technologies that make a new language possible have an

MAB '14, November 19 - 22 2014, Aarhus, Denmark. Copyright is held by the owner/author(s). Publication rights licensed to ACM.
ACM 978-1-4503-3302-3/14/11…$15.00
http://dx.doi.org/10.1145/2682884.2682893

inherent aesthetic logic – one that is grounded in media, information, the digital and computational. In this paper we explore the dimensions of a new visual language by considering the way media façades produce image. This is then extended in relationship to concepts of ambient media, haptic visuality, and an aesthetics derived from real time data, sensor networks and computation; technologies that are central to "smart city" infrastructure, media façades and urban displays. In reconsidering media façcades within the urban landscape the paper draws inspiration from Stirn's new aesthetics of urban design, which considers the poetics of urban and natural landscapes [39]. These aesthetic qualities are then discussed through a series of design explorations, case studies, drawn from the author's work with the Brisbane design firm, Kuuki. See http://kuuki.com.au/

The cases present examples where real time data sources, from both natural and human systems, are combined with abstract illumination to realise ambient media forms. This approach allows for the emergence of aesthetic qualities that go some way to addressing concerns outlined above. The case studies also provide an example of a design practice that does not fall into the established categories. The designers are not from the fields of architecture or urban design, but instead from electronic arts, interaction design and visual arts. The projects discussed are not screen-based, yet employ techniques from new media, computational arts and motion graphics. Similarly the projects are not architectural illumination; yet employ similar lighting systems in place of screens or projection mapping. This provides an insight into a practice that involves working with digital and computation materials within an architectural setting.

While the paper sets out to explore the aesthetics of media façades, it is not the authors' intention to create a unified system. Instead the focus is on sketching the salient aspects of drawn from the collision of the different fields of theory and practice that come together around urban media façades.

2. An urban aesthetics

Our experience of the urban environment cannot be easily separated from the natural environment, its cycles and patterns. The urban experience, and the aesthetics of urban landscapes, is deeply connected to weather and seasons, despite increasingly man made environments and indoor climate control. The seasons, climate and weather, have been central to the emergence of cultural habits and practices. From temperatures, qualities of light, humidity, air movement, cloud patterns, foliage (colour, presence or absence) etc, all form a changing aesthetic. Our cultures have evolved in relationship to these natural processes, and across the year they influence clothing, food, movement, social practices, festivals, events and all aspects of human dwelling. These are deeply interconnected interactions of natural systems and human society.

The constructed world we inhabit, is similarly shaped by the environment; its structures, forms, vernacular styles, and patterns of inhabitation. As ICT permeates the built environment, there is a convergence of different aesthetics – that of the natural cycles of the seasons, the patterns of human society, that of the hard material structures, and that of the intangible information and computation. The resulting aesthetic is one of both of bits and atoms, of fixed structures and changing patterns, of the actual and the virtual; an aesthetic that is an overlaying of different ontologies.

Before the emergence of ubiquitous computing and technologies of media façades, Spirn outlined a new aesthetic of urban design, a "poetics of city and nature" [40]. The aim was to revitalize approaches to urban design through the recognition of the deep interrelations between human and natural processes. Outlining an aesthetic that "includes both the making of things and places" as well as the "sensing, using and contemplating of them" [40, p108]. The relevance of Spirn's vision today, and in relationship to urban media and critiques of ubiquitous computing [3], is particularly poignant.

This "new aesthetic" of urban design, "rooted in the normal processes of nature and of living" [40], provides a conceptual bridge between the urban and the aesthetics of the new digital realm; between the actual and virtual. Virtual here is not simply analogous to digital, but instead is used in the vein of writers like Levy [24], Deluze & Guattari [8] and Hayles [19]. For Levy the virtual is a "problematic complex, the knot of tendencies or forces that accompanies a situation, event, object or entity, and which invokes a process of resolution: actualisation" [24]. For Hayles it signals a primacy of information over its material instantiation or expression [16]. Parisi describes computational algorithms as entities with unique spatio-temporal structures that are "flattened" when considered as information or as simulations of biophysical material alone [33]. Such concepts underpin a computational aesthetics, and suggest opportunities for the production of new forms of architectural expression.

Read in combination with studies of urban media cultures [35], this emergence of new media, ICT and computation within the urban environment, suggest multiple theoretical genealogies. Literature on new media [17,34,36] examines the distinctions between contemporary art and new media, what has emerged is best described as a computational post media aesthetic [28,29]. Instead of a focus on media, it considers the aesthetics the underlying information, databases, networks and computation. More recently, Bridle [6] has described a new aesthetic; primarily through visual examples that show the way digital technologies and computation reshape everyday life. Media architecture, considered as media, thus becomes problematic. However, authors such as Fraser [13] to Parsi [33] present more nuanced engagements with the convergence of architecture and ICT. For example Parsi describes the possibilities of a "semiopen architecture" where computational processes are involved in the production of new cultural actualities by transforming "infinite qualities into contingent probabilities" [33].

Media architectures, when framed as "media", as large screens on buildings, fails to engage with the possibilities of such "new aesthetic" forms. Here Spirn's new aesthetics provide inspiration through her focus on appreciation the processes that underlie the cycles and patterns that form place. One that is essential for creating designs that provide "satisfaction on multiple levels: on the level of our senses aroused, the functions serviced, the opportunities for "doing" provided, and the symbolic associations engendered" [40]. The remediated screen based visual media within the urban environment does not necessarily address these multiple levels. Yet, it is new forms of

urban media that provide opportunities to explore such questions in new interconnected way, enabled by ICT infrastructures.

Many approaches to designing and "programming" media façades remain conceptualized through the lens of previous media forms. This results in urban screens reflecting a televisual aesthetic, and controllable lighting systems being considered as "illumination" or visual effect alone. Yet the capabilities of the technologies employed present a myriad of new possibilities. For example, McCullough suggests that building façades could for example "do things over days, weeks and years that youtube clips, television ads and drive-by billboards cannot" [36]. Media façades hold the potential to tell, or embody, unfolding stories that have rich interconnections with practices, people and place – as opposed to projections of a globalized culture through a televisual aesthetic and advertising images.

Spirn's new aesthetics is more than a description of formal qualities. It encompasses the processes of dwelling – and identified that the aesthetic experience also involves the acts of making, cultivating, care, and the "contemplation of these labors and meanings" [40]. When the televisual screen enters an environment this becomes problematic. As Fry [15] points out, one of the characteristics of the televisual experience is the way it conceals its own making. Similarly Introna and Ilharco [21] describe our relationship with screens as an existing agreement, – that we agree to the screening of the screen. In this context designing media façades and urban displays requires careful attention to the ways in which the televisual not only orientates space, but ways in which screens construct the subject of the viewer.

McCullough discusses this concern as he considered "superabundant" information as an environment within which we dwell, naming it "the ambient commons" [25]. Urban media forms are a surfacing of this information environment in our perceptual field, competing for our attention, shaping our aesthetic experience of dwelling. McCullough's argument echoes Spirn's – but in a new urban context where information and media have become an inseparable part of the urban environment. This concern can be seen in some of the specific literature on media architecture, for example Fitsch focuses on the way urban media supports "long-term engagement in terms of production of content and contextual impact" [14]. When read together this raises the question - as designers of urban media, are we responsible for creating forms that embody a care for making, thinking and dwelling? Or put differently – how do we design media architectures that respond to this question?

3. Screens and Lights

Media façades are far from transparent windows onto digital worlds [4]. Transparency is a central theme in the design of televisual user interfaces. Yet the dream of a transparent interface is just that, as reveals in numerous works, Fy's critique of the televisual [15] to Bolter and Gromala's discussion of approach's to computer interface design [4]. Instead of considering the screen as an invisible window, a closer look at the way they produce image provides a first step. Specifically the way they produce image through the use, and manipulation of light in respect to surface. To do this a series of continuums is proposed as a useful conceptual tool, see figure 1 below.

The first axis is a continuum from high-resolution "televisual" screen through to arrays of controllable lights. On this continuum "LED pitch" can be considered as the key variable – until the regular placement of "pixels" is replaced with the positioning of lighting fixtures within architecture. There is thus a break point along the continuum where the array of light emitting elements can no longer produce an "image", at any viewing distance. Approaches to the design of media façades typically move along the screen to light axis. At one end they take the form of televisual screens (typically made up of closely spaced LED pixels), at the other end they are primarily lighting, or architectural illumination.

A second dimension can be added which classifies media façades in relationship to the control system and approach to how the visual content is generated. At one end are "static" works of pre-rendered material, for example looping video, pre-rendered motion graphics and light "shows" that are played back by a hardware controller. At the other end are highly computational works that employ generative algorithms and processes that are connected to external variables, often including varying forms of human interaction. While there are some notable examples of computational or generative media façades [15], these are less prevalent than those that display more static material.

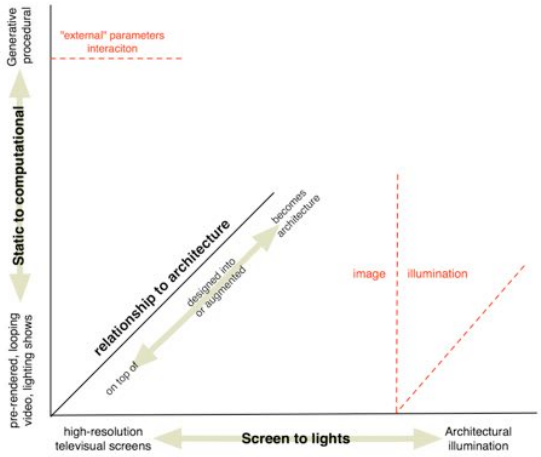

Figure 1 Classifying media façades and urban displays.

The third axis plots the relationship between light emitting elements and architecture. This continuum is more complex than a singular dimension, however it is a serviceable conceptual tool for thinking about the form. At one end are high-resolution televisual screens placed "on top of" architecture, designed for direct viewing. At the other end light itself becomes architecture, for example the lighting works of artists such as Lorenzo Hemmer and James Turrel. In between there is an integration of light emitting elements into architecture, where there is a concern for the interaction of light and architectural surfaces, for way surfaces reflect and diffuse light.

As image becomes higher in resolution it increasingly subsumes the architectural surface. This seems self evident, but in respect to the previous discussion on the televisual, it evidences the way the televisual conceals its worlding. As information "surfaces" in the urban environment in the form of the televisual, architecture gives way to the screen and its concomitant aesthetics and phenomenal qualities. However, screens can be designed into architectures in different ways, hence the

relationship to architecture is presented as a unique dimension in comparison to the screen – light axis.

Lighting elements can be considered as part of the architecture. Image can be created through a combination of direct light, diffusion, reflection, or a combination of these. However, there is no need for a work to resolve an "image". Instead, light and its qualities can be considered as extensions to architecture, or as ambient channels for information.

The three dimensions, and associated considerations, are a partial consideration of the formal qualities of media façades, and urban displays. It provides in initial outline of the "creative palette", which is easily ignored when working with prefabricated screens. Such a conceptual approach may also provide unique opportunities for designing media façades and architectures.

Interaction is another property of media architectures, however it is not depicted above, as it requires a whole paper to address in respect to the boarder literature on interaction. However, there are several aspects of interaction that are of interest in the context of the case studies below. First is the use of data from external sources (either human interaction, or other data sources) that are mapped to lighting parameters. Then there is the conceptual approach to interaction. It is either framed in respect to existing methods and techniques used for computers or phones, or interaction is (re)conceptualized in respect to the new context, in respect to the form of architecture, façades, public urban space and so forth. Media architectures provide a range of new opportunities for interaction; while beyond the scope of this paper several potentials can be seen in the case studies.

3.1 Haptic visuality

The movement between image and light suggests another useful theoretical connection that has been helpful in developing an approach to the aesthetic properties of media façades. This is drawn from the concepts of haptic and optic space, as initially outlined by Reigl [37], and described as types of visuality by later authors [31]. This focuses on the way image and space are represented and perceived in different visual media, across painting, film to computer games [28], and can be applicable to visual media within urban space as well.

Optic space organizes objects within a unified spatial continuum, and is grounded in perspective. This approach establishes a spatial relationship between viewer and image – allowing the viewer to "situate" themself as a viewing subject. In comparison haptic visuality focuses on surface, tactility and texture, as opposed to illusionary depth. The viewer is "too close to see properly" [30], Marks [30,31] discusses in relationship to screen images. In writing on Cézanne, Merleau-Ponty describes how the geometric distortions in the painters work reflect our lived perspective, where our eye does not sees in geometric perspective, as if we were a camera [32]. Instead, as in Cézanne's paintings, an "impression of emerging order, an object in the act of organizing itself before our eyes" [32], builds up through successive images from different perspectives, as our eye moves across surfaces.

We can consider media façades, which move away from screens towards light, from a similar perspective as Merleau-Ponty discusses Cézanne's work [32]. The perceptual experience of media within an urban setting is, to echo Cézanne, an immersion in the visual field [16], touching light with the eye. "We see things; we agree about them; we are anchored in them" [32]. Read in relationship to the previous discussion on the televisual, and the agreement to the screening of the screen [21], the design of media façades is not just part of the human world, but can be thought of as constructing a world.

In the design of a screen the objective is to have a continuous image across a surface where juxtaposed pixels of colour cannot be distinguished. For a low-density lighting work, the individual lighting fixtures illuminate architectural surface and detail, light is reflected or diffused by the architecture, creating gradients of tone and colour across surface, multiple outlines. Such illumination makes it impossible for an image to erase architecture, instead it appears illuminated from within. This interactions of light and surface, reveals the texture, contours and details of the architecture and materials, while at the same time becoming an extension of the architecture.

It should be noted that depending on the screen content, and proximity of the viewer, high-resolution urban displays exhibit haptic visual qualities. However, it is the lower density media façades, integrated into architectural forms, which become increasingly tactile. This tactility is an important aspect of the experience, and draws our attention to space and structures, to the different interactions between light, surface and image. This signals a meaningful relationship between the virtual, the electronic media image and architecture, as opposed to the projection of televisual optic space on top of architecture.

3.2 Ambient

"Fish don't know water exists till beached" [27].

Another aspect of media façades is the approach taken in respect to human attention. Urban screens, while not necessarily at the center of attention, are often designed for direct attention. i.e. the logics suggest or require looking at. Yet our experience of the environment is grounded in innumerable subtle (or ambient) sensory phenomena – the quality of light, air temperature, humidity and air flows to name but a few. This phenomenological grounding has informed a movement in the design of ubiquitous computing referred to as "ambient media."

First described in the 1990s, in the work of Ishii [22][43], ambient media approaches the presentation of information at the periphery of attention. Ishii's vision saw the potential in manipulating subtle properties of an environment, at the edges of perception, to communicate information [22]. Fast forward 15 years and we dwell, as Hill suggests, in a "gentle ambient drizzle of everyday data" [20]. This information environment is conceptualised as being "invisible", yet McCullough argues that it is a form of new commons, in which all manner of information competes for our precious attention. This information is made visible (perceivable) by way of screens, but is also a persistent background of technology, platforms and infrastructure.

Urban media programed following the televisual logics, produce environments where attention become fragmented, where "movement" becomes analogous to web surfing. What results is a field of unrelated attention seeking visual memes, distractions, messages for others, or enticements for the unsuspecting. Returning to Ishii's initial outline of ambient, being at the periphery of attention, there are cues to new ways of conceptualizing media façades.

Ishii's ambient media suggest two key directions. First information does not need to be designed for the center of perception, or presented in "didactic" ways. Secondly, all

manner of subtle properties/qualities of an environment can be used to convey information. This second observation points to the realization that our experience of space, and the appreciation of our environment is not singularly based in what we are paying attention to visually. While our visual senses may be dominant; it is our other senses that ground us in the world.

Connected to real timed data drawn from any manner of sources, media façades can become meaningful "ambient" evolving forms. Integrated into architecture, buildings can be considered for example analogous to flora – blooming in spring, changing colour with the seasons, or in relationship other data sources that capture social patterns. This draws us back to Spirn's new aesthetics of urban design. Media façades and urban displays can be designed to draw out connections between human and natural systems, and potentially enrich the experiential aesthetics of dwelling within urban environments.

There are many examples of ambient media façades that employ the approaches described above. Two notable examples combine computationally controlled low density media façades with data that creates a direct connection between illumination and natural phenomena. In this combination the media façade forms a locus between natural and artificial (both physical and digital) worlds. An early example is Christian Möller's *Kinetic Light Sculpture* installed at the *Zeilgallery* in Frankfurt. The work uses weather data from a station on the building to vary hue and pattern of light across a façade. Illumination is created by floodlights behind perforated aluminum façade, which results in gradients of colour that follow the form of the architectural façade. The illumination moves from blue to yellow, with the amount of yellow light, and its movement, mapped to temperature wind and rain observations. There is no attempt to create a legible weather beacon with an easily read key, but instead live data becomes an ambient indication of weather. An LED screen, similarly behind the façade, displays real time noise levels. What results is a façade which changes in relationship to it's surrounds.

More recently, Jason Bruges' *Showtime* media façade in Leicester Square London 2010 uses images of the sky recorded during each day to determine lighting colours. At significant moments during the year, for example Chinese New Year or film premieres, this programming is varied to present displays relevant to the specific events. Lighting elements, vertical strips, are placed within the façade, with the resulting reflections and diffusion producing gradients of colour around each element. The media lighting elements are very low density, and unable to resolve a televisual image. Yet the integration into the architecture and the use of a meaningful data source see the work becoming an extension of the architecture. This is an approach that connects media to location – drawing upon on of the more ephemeral qualities of a place, its light.

In both works there has been an integration of light producing elements into the architecture resulting in an interplay of light and surface. In this way neither erase architecture or materials of the façades in preference of digital image. In fact neither of these examples can resolve a high-resolution image, thus each are at the light end of the screen-light continuum. In both examples real-time data drawn from local conditions is used as an input to generative processes that cerate the resulting lighting program. The resulting visual effect is not random, but instead has meaning in respect to the experiences of each location: weather and noise in the case of *Zeilgallery*; and, qualities of light and social events in the case of *Showtime.* These are only two examples of ambient media façades, which provide alternatives to the large urban televisual display, and suggest further study of façades using the proposed continuums.

4. Explorations

Following are four case studies, which represent different "explorations through design" of the concepts discussed above. Each work focuses on a different interaction between people place and technology. All can be viewed as forms of media architecture (or façades) that are ambient in nature, as opposed to demanding focal attention. They have been designed with the principles above in mind, with the discussion providing an insight into these principles in action, and the diversity of resulting designs.

Each of the cases was realized by Kuuki, a Brisbane based design firm who take their name from the Japanese term kuuki or 空気. In Japanese, kuuki literally means air or atmosphere, and is often used to describe the air of a place or the social atmosphere [41]. Kuuki is also used to refer to understanding without explicit information; unspoken mood or feelings; the air or atmosphere of a situation; and, the relationships or interactions in a situation. Thus alluding to the structures of tacit socially acquired knowledge, or "the ambient" [25]. Each of the cases below aim to embody some of this spirit of Kuuki.

4.1 Kiss: Haptic visual experience

The first case, *Kiss*, focuses on the aesthetic movement between screens and light, and an alternate form of interaction in respect to people and screens. The interaction design aimed to connect people, and draw attention away from the screen, with light occurring in periphery of the visual field.

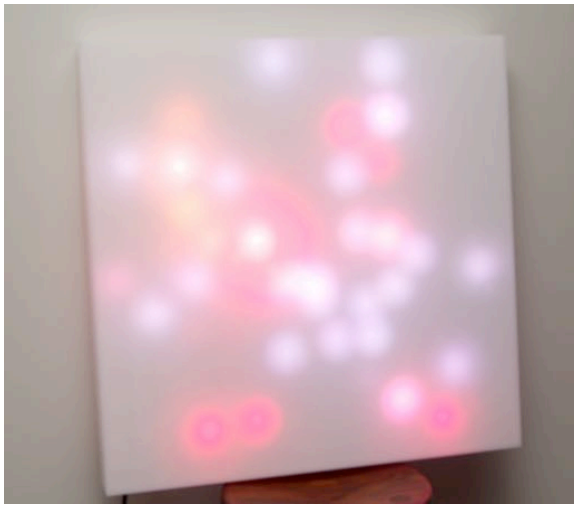

Figure 2 *Kiss.* By Bracks & Sade, Kuuki 2012.

The work is an initial step towards decomposing the regular gird of the pixel placement within a screen. There is no need to place lights in a regular grid, and irregularly placed light sources remain capable of creating "images" through use of suitable mapping techniques. Many advanced lighting control applications are capable of mapping lights in space, and allow designers to use screen-based tools to develop programs and lighting configurations irrespective of "pixel" location.

In *Kiss* the placement of 100 LED "pixels" within a square form follows a phylotaxis pattern (see figure 3). This is a crisscross spiral pattern regularly observed in nature, and easily modeled in software allowing for the fabrication of a structure to mount lights. The control software (written in Processing) maps image onto this irregular placement of pixels. Such a low-resolution display was not able to resolve images – but could produce highly impressionistic representations.

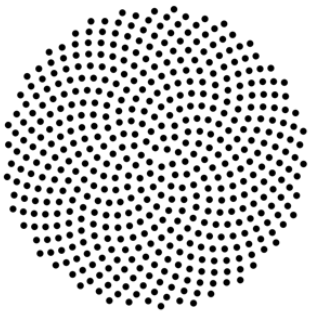

Figure 3 Phyllotaxis pattern used to determine LED placement

This visual aesthetic was further developed through experimentation with the way light was diffused by the front perspex layer. As seen in figure 2, the diffusion layer does not produce a uniform colour gradient, but instead generates what appear as halos of colour and other artifacts. If the aim was for a screen capable of displaying representational images these could be considered aberrations, however in this context the interactions of light and materials become part of the creative palette. The aim in *Kiss* was to create a surface for abstract lighting effects, and the feeling of being "too close", immersed in a visual field of experience.

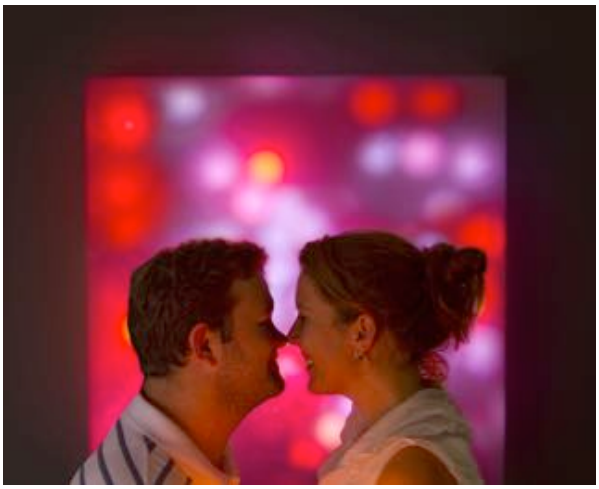

Figure 4 Interaction based on recognition of 2 faces in profile looking at each other.

This approach was coupled with an interaction design focused on drawing people to the work and interacting with each other. The lighting patterns when first seen are subtle and slowly changing. The surface only comes to life fully when two people stand in front of the piece looking at each other (and not the work) for a specified period of time. Capturing the moment before kissing. The work recognized two faces in profile, and after a time lighting effects, a fleeting response of white light – like sparks flying - occur at the periphery of vision. For other viewers the lighting effects silhouette the profiles of two people. These effects rapidly fade when the pattern of two faces in profile is no longer visible to the camera in the work.

In an age of mobile phones, Facebook, Twitter and online dating, interactions in mediated environments often outnumber face-to-face encounters. This moment – as two people look at each other – is a primal moment when two people recognise each other. Such encounters are a privileged phenomenon in which the other person's presence and proximity are strongly felt. By asking viewers to be intimate in public and look at each other for longer than otherwise socially normal, the work draws our attention to the other. To explore the face of the person we are looking at, and see that they are human like us, is central to an ethics of care [23]. This is to experience beauty, difference, discomfort, perhaps even nervous laughing, before turning a more intimate moment of recognition.

4.2 Acacia Light Wall: Ambient seasonal

The second case takes form of a permanent media façade, and focuses on the way a location can inform the design of an ambient work, which evolves very slowly over extended periods of time.

The *Acacia Light Wall* is a permanent public artwork at *Eden*, a three building residential complex on the Yarra River in Melbourne, Australia. The artwork is mounted in the entryway of the building *Acacia Place*. The artwork is on two walls, 10 - 12 metres long and 3 - 5 metres high respectively. The work was designed in response to the building's location on the banks of the Yarra River, where there is remnant native bush land along the riverbanks.

Figure 5 *Acacia Lightwall*. By Bracks & Sade, Kuuki 2013.

The façade takes the form of large backlit stylised screens, inspired by tangled branches of Australian wattle trees (see figure 6). The lighting design aimed to create abstract ambient patterns, which reflect the local environment over the seasons. The positioning of lights within the work, to form the patterns and gradients, is not uniform but follows the same natural growth pattern of the surface. The resulting illumination patterns compliment the screens visual form, and resonate with the relationships between foliage, branches and light.

Between sunset and sunrise, the façade displays slowly morphing, organic lighting effects of colour drawn from local flowers and foliage. These patterns move incredibly slowly and

are almost imperceivable upon with a quick glance.[1] These colours and patterns also evolve across the year as different plants bloom in gardens and bush along the adjacent river. Forming a connection between the programming of the media façade and local natural cycles.

Figure 6 Natural growth patterns informed the visual structure

Each year, the work takes local residents on a journey from the flame colours of deciduous autumn leaves and burnt winter grasses, through to soft yellow blossoms of eucalypts in spring and the hot-pink flashes of *Carprobrotus rossi* in summer. It's visually engaging as it change every week, but as in nature, similar colours appear at the same time each year. In this context predictability is exciting, not dull. It encourages residents to explore their local natural environment, discover the plants that match colours in the wall, and look forward to seeing these plants appear year after year.

This work attempts to draw a connection between built environment and natural processes. It explores the possibilities of media façades in a manner echoing McCullough's comments that media façades provide the chance to work with time in a different manner to the fast jump cut of the televisual. The façade surface has avoided the temptation to become a televisual screen. Instead aiming to create a design that has longevity in terms of its visual interest during both day and night time, and for residents and locals who live with it over extended periods of time, as part of their "home".

4.3 Everyone, Everyday: Tactile ambient information visualisation

The third case focuses on the ambient visualization of energy use, and was presented as a temporary lighting work at the VIVID Sydney festival in 2013. The work was informed by previous writing on the logics of electricity monitoring and interaction design [38], and a previous illuminated visulisation of CO2 data from ice core samples [39]. *Every One, Every Day* takes the form of a cube with a volume of 27 cubic meters. The annual per capita emissions figures for Australia are cited as ranging between 18 to 25 tons. Assuming the lower figure, 18tons per capital annually, the 27 cubic meters represents approximately one day per capita of CO2 emissions – where CO2 is a gas at 15C and 1 atmosphere of pressure.

[1] See this video for an example of the work movement over time https://vimeo.com/79088512

Figure 7 *Everyone, Everyday*. By Bracks & Sade, Kuuki 2013. Installed at Walsh Bay, Sydney Australia.

Inside the cube is an array of over 600 controllable LEDs, mounted in a spherical shape. At first this seems like an inefficient way to produce a lighting effect as the cube could have been illuminated from within by far less higher-powered light sources. However, the aim was to create a method for producing complex patterns across a diffusion surface, and to give it a highly variable (and controllable) visual texture not possible with other methods.

The work is an example of ambient media in the way it connects illumination patterns to real time data from the Australian Energy Market, specifically the dispatch interval price and total energy demand for New South Wales. The two variables, of demand and price, are mapped to parameters of dynamic lighting effects – changing hue, brightness, movement, frequency etc.

The graph in figure 9 shows how these two variables change over a normal day. Similarly across the year the daily patterns vary in relationship to the seasons and events, for example periods of extreme hot and cold increase demand based through increase use of air conditioning. The daily patterns reflect human patterns of dwelling, with the evening increase in demand coinciding with people returning home from work, cooking dinner and using other household appliances and so forth. Energy use is only one of untold data sets that provide a window into human practices and social processes.

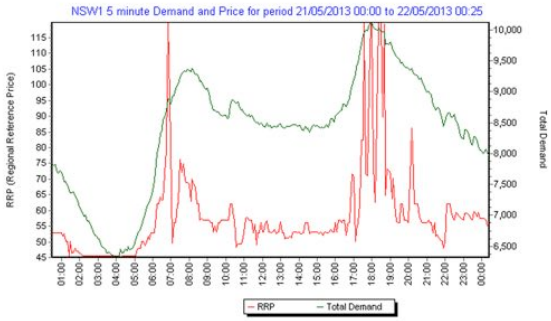

Figure 8 Graph of electricity demand and price for New South Wales, on 21 May 2013.

The temptation when working with energy data figures is to employ a mapping of energy use to a visual cue which signals a simplistic higher use is bad, lower use is good. However, such a reading over simplifies a very complex system, and is predicated on the logics of electricity production from a scare and polluting resource as opposed to renewable resources that produce less

pollution. In *Everyone, Everyday* energy use was mapped from cool to warm colours – with the work producing a warmer glow as the "hearth fired up" in the evening and cooled into the early hours of the morning.

The process of creating mapping and effects was made easier by the ability to analyse data from previous years, and by the short nature of the installation. For permanent installations such mappings become more complex and need to consider longer timeframes and the associated variability.

The surface of *Every One, Every Day* is clad in tiles made from polyethylene, from primarily recycled milk bottles, 'lent' to the artists by the Visy recycling facility in Sydney. The aim was to create a work that could be recycled – in a cradle-to-cradle manner [26]. As such the work can be viewed as an intervention in the industrial ecology of polyethylene, and in the process demonstrates how to sustain cycles of technical materials – by taking the output of a recycling facility back to a manufacturer to produce usable materials.

Figure 9: *Everyone, Everyday.* Appearance during day time, showing tiles and texture.

The tiles were highly textured, and this resulted to an emergent interaction with the work that was not an initial design intention. The texture of the tiles led many people to touch the work, to run their hands across the surface, and thus view the surface up close. Similarly, the festival show a seasonally unusual amount wet weather, which produces unexpected visual and tactile outcomes. This highly touchable nature of the work combined with the abstracted illumination method produces a haptic (tactile) visual experience with a deep connection between material, scale, visual patterns and human activity.

There are many examples of similar ambient displays of energy use, from in the home [2] to on an urban scale [11]. While *Everyone, Everyday* is not unique in this aim, it is however unique in the way it combined physical structure, material, illumination, and interaction, into a meaningful whole. In this way it tells a story about the practices and patterns of our dwelling, without resorting to televisual images or common tropes.

Figure 10 Showing people touching the surface, drawn "too close" - an unusual action for a media façade which is typically looked at.

4.4 Suzumushi: information ecologies.

This final case predates the first three, and is less of media façade. However, it is included as it provides cues for future possibilities that have not been the focus of the mainstream work in the field of media façades. It explores the interrelationship between natural and information ecologies.

Figure 11 *Suzumushi.* By Bracks & Sade, Kuuki 2011. Installed at State Library of Queensland.

Suzumushi is a collection, or swarm, of 60 stylised crickets installed at the State Library of Queensland (SLQ) for an exhibition in 2011. The swarm forms an adhoc XBee wireless network communicating in short bursts in the range of 2.4Ghz. The crickets' calls have been transformed into onomatopoeia displayed on a small LCD screen on their back. The audience thus speaks the calls aloud or as an inner voice, as they attempt to pronounce "tz tz tz tz tz" or "rin rin ricket".

The seasonal experience of crickets and their calls, and notions of acoustic ecology inspired the work. The crickets in *Suzumushi* make calls in relationship to the 'seasonal' patterns of users searching the SLQ databases. Each cricket also displays these search terms, and uses them as part of their call to others. The pattern of memes that pass through the swarm across the day, weeks and months, provided a unique insight into the invisible use of the SLQ databases. At times the swarm displayed strings of numbers that seem intriguing until one realises they are searches for ISBNs. During schools hours on weekdays the searching of school groups drown out any other terms, and overnight searches by genealogist, historians and researchers see the swarm speaking the family names of

ancestors. Noisy swarms of insects blend into noisy crowds of people, which in a digital age occur not just within the physical world, but a silent environment – beyond our auditory capabilities. Glimpses (or the auditory equivalent) of which we hear as static of a detuned radio, the once iconic sound of a modem, or the chirping of a mobile phone as it induces a current into speaker cable. Descriptions of the urban information environment echo such concerns for "noise" [25] as information competes for our attention.

Each *Suzumushi* is a stand-alone electronic object that will function as an individual, but when in the proximity of others will become part of a larger swarm. The behavior of each *Suzumushi* is influenced by the calls of other crickets, and modeled upon different insect behaviors. For example, the patterns of cricket calls as they compete to attract a mate, and the relationship between call frequency and temperature [9]. The work is also informed by the cyclical nature of firefly flashing and resulting synchronicity. This synchronicity in a congregation of flashing fireflies is the result of each one continually sending and receiving signals, yet there is no central conductor, instead this synchronicity is emergent [41]. Similarly each *Suzumushi* responds to the radio frequency chirps of other crickets – competing for attention, influencing the call cycles of each other, and propagating texts heard from the network.

Individual crickets in the swarm also respond to sound in the environment, with noise triggering calls and influencing call cycles. The audiences may talk to a cricket or make other sounds, which will eventually alter the behavior of the swarm. This ability to hear allows the swam (as a whole) to map the acoustic environment within which they exist. Loud sounds heard by one member of the swarm triggers calls, and a cascade of interactions between other crickets. Such a sensor network could be used within a large-scale media façades or across a city – becoming more than simply "display".

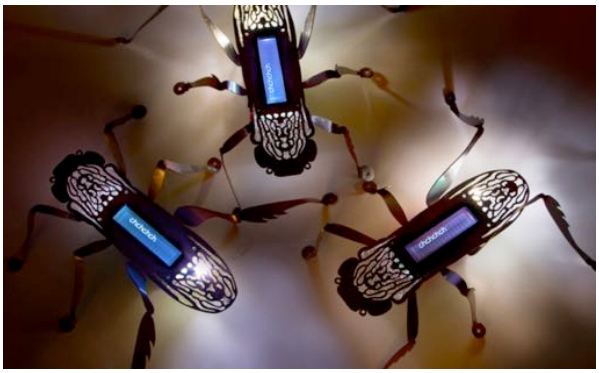

Figure 12 *Suzumshi*. Detail of 3 crickets.

When put together in a group of 5, 25 or 50, differing patterns emerge. In *Suzumushi* there needs to be a mass of crickets between 45 and 55, one or two do not make a swarm. This emergence of order, or pattern, from the swarm is the result of the interactions between so many individual *Suzumushi*, as well as interaction with the network data sources and the environment. When encountered *Suzumushi* tell the story of the "ecologies" that they exist between. It draws connections between human activities, memories and experiences, and grounds these within architecture and the acoustic ecology of a place. It embodies Kuuki's approach, which Brown describes as "light and playful coercions (…) unwittingly leading [the audience] via a natural and seductive interaction into a space where a more profound comprehension of our world and our place in it can emerge" [7].

Suzumushi could be considered an *"anticipatory system* that is apt not only to programed response, but also to generate potential conditions for interaction from the open-ended evolution of algorithms" [33]. Such an approach presents new challenges for designers focused on immutable material structures, or information systems alone. Yet the technologies that create media façades are naturally disposed to such methods, driven by computational devices, connected to networks, and reconfigurable sensor outputs. Thus, this work suggests a radical approach to design – where media façade as array of light emitting elements becomes a swarm of agents responsive to their environment, communicating across the networks that underpin the ambient commons. The optic space of the screen has been completely decomposed and reconstituted – suggesting a movement from image through architecture to individually meaningful element. Upon close inspection each cricket tells its own story within the greater whole, no longer a pixel subservient to singular image within a rigid spatial arrangement.

5. Conclusions

In the examples discussed, and in respect to the initial sketch of aesthetics, it becomes clear that media architectures, as part of our "ambient commons", is inseparable from the environments that support our dwelling. This paper has outlined one way of re-conceptualizing media façades, drawing upon theories ambient media, haptic visuality and urban aesthetics. These have been explored through multiple design projects, which provided for a developing appreciation for the properties and qualities of this "new visual language" [1].

The cases discussed all move away from the televisual screen towards controllable architectural illumination, and away from "static" works towards computational displays. The approach to design of each, and use of lighting control, is drawn from new media arts (computational arts) practices – as opposed to being either scheduling of motion graphics or video materials, or pre programmed "lighting shows." In each data sources, human interaction, and computational processes are used to create "semi-open" [33] works where the emergence of order is grounded in meaningful connections to the "processes of nature and of living" [40].

Finally, it is a question posed by Spirn that will motivate future work: "what are the forms that express contemporary cosmology, that speak to us in an age when photographs of atomic particles and of galaxies are common place, when time and space are not fixed but relative, and when we as humans are less certain in our place in the universe than we once were." [39 p124] Today it is possible to see forms within the urban environment that reflect a computational, or virtual, "cosmology". For example, architectures created by way of generative algorithms, bio mimicry, as well as a number of contemporary media architecture projects. Ultimately it is urban media that will provide opportunities to explore such questions in deeply interconnected ways, enriching our lived experience, and the environments within which we dwell.

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Probing the network.
Architecturality of Wireless Infrastructure.

ABSTRACT

Mobile devices and wireless networks have a prominent place in our interaction with the environment and with each other. Like every new technology, it has been a subject to inflated expectations. Scholars, writers, artists and architects have explored how this new digital layer could *reconstitute* our experience of the 'real' urban world, *reconfigure* space and finally, *recompose* social interactions within it.

In reality although hardly negligible, its impact has not been that spectacular. In this paper, we will outline a set of design and artistic practices attuned at understanding and articulating the interplay of the social, digital and physical infrastructures. These artistic and design artefacts outline a tangible territory of interactions which contributes to our understanding of the physicality of wireless communication and its coexistence within built architecture. Aesthetic experiments, playful interventions and critical designs all conceptualise interaction with an otherwise insensible infrastructure. We will identify common threads in the ways these artworks manipulate the wireless 'material' with a focus on the underlying motivation and resulting outcomes. Based on this, we will discuss these practices in the light of their relevance for and reference to architecture.

Categories and Subject Descriptors

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms

Algorithms, Measurement, Documentation, Performance, Design, Experimentation, Human Factors

Keywords

Wireless, infrastructure, interaction, network, spatial experience

MAB '14, November 19 - 22 2014, Aarhus, Denmark

ACM 978-1-4503-3302-3/14/11…$15.00
http://dx.doi.org/10.1145/2682884.2682889

1. INTRODUCTION

We walk around with mobile devices which can communicate with devices around us, as well as with remote ones through central service providers. These devices form a large network of antennas and gadgets that affords seamless flow of information through constant exchange of wireless signals. The signals are part of the wireless communication infrastructure, high-frequency waves transmitting data through space.

When equipped with such a device, we call it 'being' online or 'having' signal. What this actually means is that our device is able to receive and extract meaningful information from electromagnetic signals that propagate through the space, and represent it to us in a human-readable form.

What is wireless communication infrastructure? In the past decade numerous architectural, design, artistic (*Haque design + research*[28], *The Sentient City*[56], *Touch* research project[1], *Weise7* [44,45,46] *Jellitch*[31]), curatorial (*Art+Communication*, Riga[49,50], *Radiator,* Nottingham[66], *Invisible Fields,* Barcelona[39], *Sensing Place,* Basel[30]) as well as some academic inquires [16,18,22,34,41] discussed the topic. Wireless communication can be considered from both technical, social, political and aesthetic angles, thus the discussion on it crosses fields of expertise and interest as diverse as sociology, psychology, politics, philosophy, phenomenology, urban studies, architecture, computer science, electrical and communication engineering. All these angles use different instrumental lenses when evaluating its performance. Technically it is an infrastructure which needs to function as seamlessly as possible; it is evaluated in terms of availability and speed, and continuously optimised. While gradually becoming indispensable, these infrastructures begin to figure as "sites of cultural contestation" [40], gaining significance as social or cultural infrastructures. Politically, this discussion raises not only questions of accessibility and distribution (who can use the infrastructure and where?) but of political structures and societal models behind it (e.g. central service providers as opposed to peer-to-peer networks [38]). Finally, it is the phenomenological discussion on (ambiguity) of perception (e.g. Merleau-Ponty's work on The Visible and the Invisible[43]) that inspired a large movement of structural and aesthetic inquiries into the properties of wireless communication. Following on the philosophy "one must see or feel in some way in order to think"[43:146] artistic and design practices have engaged in a myriad of ways to provoke thinking about *wirelessness*.

2. SPATIALITY OF WIRELESSNESS

Some time ago, there was a belief mobile technology was going to "liberate" people from space, or at least diminish the role of distances [9,59]. Globalisation theorists argued that in compressed space distances play no role any more [59]. We can find critique of the oversimplification this assumption brings with reference to infrastructures and their global distribution already in the work of their contemporaries like Graham, Marvin [20,21], and Thrift [65]. Nevertheless, with the expanding use of Wi-Fi and other wireless technologies, the information became more easily accessible - anywhere and at any time. Today, we no longer need to go to a particular place to retrieve a particular piece of information (like a birth certificate from a city hall or the price of a dish in a restaurant).

The widespread of mobile technologies brought about a shift in the trend of location irrelevance [18]. What happened instead of compression of time and space is a distribution of communication devices that augment locations. Caused by the same technical looseness, this shift is primarily manifested in the fact that we are more likely to be online in a café, scrolling on a smart phone then attached to a screen, mouse and keyboard in a dark room. We are increasingly attracted to particular places by social and technical connectivity. On top of this, our presence is extended to different realms of social spaces with the help of location-aware applications [18]. While it is difficult to pin down exactly the role of the physical environment, the properties of space do affect our mobile interactions (see for example the work of Dan Hill on the use of Wi-Fi in the State Library of Queensland[29]). At the same time, the propagation of wireless communication signals takes up actual space and has measurable physical properties.

In his discussion on natural and artificial sciences, Simon argues that artefacts are not apart from nature; they obey it's laws and are affected by nature [57]. In a similar way, wireless signals are man-made (or man-induced) artefacts adapted to human goals and purposes which coexist with the built and natural environment. Mackenzie defines *wirelessness* as "a sensibility attuned to a proliferating ethos of gadgets, services, opportunities, and enterprises that transmit and receive information via radio waves using Internet-style network protocols"[41:29]. Although imperceptible to human senses, wireless communication signals cannot be considered immaterial as they are subject to the same laws of physics like X-Rays, radio waves and other electromagnetic radiation. Their propagation is affected by the environments configuration and conditions. It affects the experience and functioning of the environment in return.

There is a growing body of research that investigates the relationship between wireless communication and space in everyday situations. Forlano's research into Wi-Fi Geographies[15] and the co-production of place by so-called urban technologies (location–based social media applications) [16] recognizes the material and spatial relevance of wireless networks, analysing it from the perspective of the resulting lived experience. Hampton's investigation in the social life of wireless spaces [22,23] focuses on the interactions within these overlapping environments (the wireless and the built) with a focus on immergence of private spaces within public space due to connectivity. He too acknowledges the relevance of actual physical space for the interaction. Unlike research practices which use methods typical for social sciences (surveys, interviews, field and ethnographic observations) and study everyday situations (the use of wireless networks in cafes and public parks), this paper explores understanding of and interaction with wireless networks network through disruptive situations created by works of art and design. We will particularly focus on architectural aspect of wireless signals, their presence in space, and the way to experience them tangibly. Through an overview of examples from contemporary media design and media art practice we will try to gain a better picture of how these waves could be rendered visible, audible or in other ways *experienceable*. The practices in question do not simply visualise the waves, but tackle their spatial properties in an insightful way.

3. CONTRIBUTION TO ARCHITECTURE

How do media art and design practices relate to architecture? In their investigations in the interaction between code and space, Forlano and Kitchin and Dodge came up with the notions of *codespace* or code/space, respectively. They observe code intertwined with space in such a way that new qualities of both come into being, reorganizing people, places and information [15]; and recognize the agency of code in producing a particular spatiality [34]. Such conclusions create space for new theoretical concepts needed "to better understand the interaction between physical and digital space" [15] and develop "a nuanced understanding of how these theoretical concepts play out in everyday work and life in cities." [16]

Traditionally, architecture is considered a profession of building something new and not of revealing something that is already there. From this perspective, the practice of revealing electromagnetic signals in space is not very architectural. This of course depends on the way we define space in the first place. In Usman Haque's discussion on dynamic view of architecture [24] we can recognize a historical upbringing of the idea that first troubled architectural avant-garde from the 1970s. This avant-garde discourse incorporated the idea that architecture is not simply about designing buildings. After years of belief in the power of architecture to transform the lives of its occupants which fuelled the practice of modernism and post WWII 1960s movements [52], it became clear that such revolution might well not happen. This realisation triggered a reaction amongst the then young professionals to embrace different 'unbuilding' practices. For example, in Tschumi's view architecture had to negate what society expected from it and instead, engage in design of subjective experience of spaces [67]. Using his 'paper spaces' as a tool to criticise and reflect upon architectural theory and practice, Tschumi is distancing himself both from the functionalist approaches of modernism and the stylistic preoccupations of his post-modern contemporaries. Architecture was seen as a means of communication, defined as much by movement and event as by the walls.

If we compare this to the contemporary view of the role of networks and location-awareness we will find a striking similarity in the language. We have already mentioned the expectation from the electromagnetic signals to shape spatial experience much like walls do, or as Tshumi sees it, like movement and event do. Wireless communications become part of this movement.

In a practical sense, the artworks that will be discussed engage with an opposite process of Tschumi's and his like-minded colleagues. They give materiality to an otherwise hardly perceivable or palpable infrastructure which acts as a meta-architecture within the built environment. They do so in order to allow for critical reflection on the propagation and availability of signals. In some ways, the motivation behind Tschumi's work and contemporary media design and art practice is similar. Both

contribute to a broadening of the meaning and role of architecture. Giving form to something that is fluid, in constant flux and which cannot be experienced with our bodies gives architecture a whole new field to engage with – using networks as material, sculpting and disrupting the so-called immaterial space.

4. DESCRIBING THE "HERTZIAN" SPACE OF WIRELESS COMMUNICATION

Wireless communication infrastructure is built from scattered devices at the edges of telecommunications and network infrastructures [41], interconnected by high-frequency waves transmitting data through air. Wireless signals are at the same time the message and the infrastructure for communication. Artistic exploration of materiality of this imperceptible sphere tends to escape the hierarchy between message and the medium[35]. It focuses the attention on social and political aspects (take for example Paul Graham Raven's "Infrastructure Fiction" [19]) as well as aesthetic and interaction concerns (demonstrated most clearly in numerous visualisations of RFID, Wi-Fi and GSM signals, for example the one by Nickolay Lamm [36,37]) with the infrastructure otherwise discussed from an instrumentalist perspective.

Ever since Anthony Dunne published his RCA doctoral thesis [11] and subsequently the influential "Design Noir" with Fiona Raby [13], the term 'hertzian space' become widely used by designers and artists to refer to the vague terrain of wireless communications, electromagnetic radiations and their spatial, social, cultural and political representations. For example, a design education project, Trails Forever explored the use of wireless technologies as "non-intrusive" interpretation systems in 2004 [64] based on the concept of Hertzian space by Dunne. Mark Shepard showed his Hertzian Rain event structure in 2009 and later wrote on Hertzian Space for the "Architecture/Action" issue of Vague Terrain journal [55]. The first comprehensive overview of these "hertzian" activities was offered by "The Atlas of Electromagnetic Space" in 2008 [5]. Designed by Bestiario, an information design office from Barcelona, the Atlas served as a database of artistic and social interventions that employ radio technologies.

From the perspective of physicality/materiality, Hertzian Space is a direct inverse of Cyberspace – while the last is a metaphor of what happens within computers, "radio space is actual and physical"[12:101]. Referring to waves oscillating on frequencies expressed in Hz (SI unit of frequency named after Heinrich Rudolf Hertz), Dunne defines 'hertzian space' as "a holistic view of the electronic device and its cultural interactions" [12].

The problem when working with these invisible or otherwise insensible materials is that there is immediately an expectation of some kind of translation (e.g. mapping values of signal strength into perceptible values of light or sound). Dunne tried to explain the difference between visualisation and the work which "does not discuss making the invisible visible…but explores the links between the material and immaterial that lead to new aesthetic possibilities for life in an electromagnetic environment" [12]. Many artists have dealt with it since and some of this work has contributed to better understanding of what 'hertizan space' means to us, and how it can be experienced.

5. WIRELESS MEDIA IN DESIGN AND ARTISTIC PRACTICE

Contemporary art scene and in particular media art practice have been continuously tackling the political, social and phenomenological aspects of the electromagnetic spectrum. A series of exhibitions and festivals like the Art+Communication festival in Riga [49,50], Radiator in Nottingham [66] Sentient City project [12] and the more recent Invisible Fields Exhibition, Lighthouse [39] and Sensing places, Basel [30] demonstrated ways to "take control of the very principles and materiality of the 'network waves'."[35]. Several artworks are prominent across these events, giving them a representative role in the discussion on spatiality and tangibility of the wireless network layer. In their unsystematic explorations of interaction with wireless signals, these design and artworks question the interaction between people, technology and space. Because of the way they deal with network and platform politics, we could say they are "extending network politics into a hands-on approach to basics of network communication" [47], manipulating networks for different artistic purposes.

We will describe some of these works in order to gain insight into the motivations and technologies driving their production. We will observe general motivational as well as technological trends amongst them. Before we discuss the artworks in detail, we will introduce three general categories which should help us analyse their scope and contribution to the questions of architectural tangibility and experience. The categories serve to group works around common characteristics rather than to separate them into distinct categorisation. A timeline diagram and a comparative chronological table with basic information on all artworks that are considered relevant for this research can be found at the end of the paper.

5.1 Aesthetic translation

The translation involves relatively direct mapping of wireless signals onto visual, sonic or other media. A measurement of a network value (most commonly signal strength) is assigned to another value in a physical system - position on the screen, colour, height, depth, pitch, or speed. These works are most often static, in the sense that they don't respond to the networks in real time, but are rather displayed as renderings, images or sculptures of value sets which were given form after collecting data. "Immaterials: Ghost in the field"[2] by the Oslo based Touch team and "Bleeker Street Documents"[31] by Austrian architect Peter Jellitch are the clearest examples of aesthetic translations. "WiFi Camera"[58] produced in collaboration between Bengt Sjölén, Adam Somlai Fischer and Usman Haque as well as "Observatorio"[6] by the LaLaLab duo are dynamic visualisations of the presence of wireless networks. However, because of their objective approach to the signal availability they are closest to aesthetic translation as a strategy.

5.2 Playful Interventions

Playfulness is understood here as the use of signal availability and/or data traffic as a dynamic value in creation of tangible experiences. It includes the introduction of a dimension that is controlled by the artist (be it the manipulation of location as in distributed sound pieces, light painting walk, or senses like pressing, vibrating; or another material like light or video). They are not independent from wireless infrastructure as an input, but they incorporate additional material. These works tend to interpret both physical properties of wireless networks and their impact on

people. They engage with controlled network traffic to generate interactions between people, environment and information. Starting from Jim Campbell's "Portrait of Rebecca"[8] through Usman Haque's "Sky Ear"[25] and "Hertzian Rain"[54] by Mark Shepard, these artworks combine wire(less) infrastructure fluctuations with their own medium of expression, be it a video, light or sound (respectively). "Constraint City"[51] by Gordan Savičić and "Immaterials: WiFi Lights Painting"[3] by the Touch team, although basically translating wireless network signal strength into pressure (pain) or light *spatialise* this information in a manner chosen and performed by the artists. Playful interventions are predominantly real time oriented, reacting to different properties of wireless signals (strength, ESSID, encryption type etc.) dynamically.

5.3 Critical or Subversive Design

Critical reflection and subversive intention is aimed at directly affecting propagation of signals or another usability aspect of the infrastructure. It makes it unavailable or interferes significantly with its functionality. It requires high technical literacy and understanding of how a technology works. Thus the Oliver and Vasiliev's intervention "Newstweek"[46] for example, intercepts communication between the access point and devices connected to the network through a method called 'Man in the Middle Attack' or ARP Spoofing which is used by malicious attackers to intercept, modify, or even stop data in-transit, but also as a way to implement redundancy of network services [17]

5.4 The artistic and design practice

In the era before *wirelessness,* the "Portrait Of Rebecca With Power Line Fluctuations" by the San Francisco based artist Jim Campbell examined the dynamics of an infrastructure *normalised* long time ago, namely electricity. It rendered fluctuations of the power line visible through an interaction between a portrait and a light bulb on a TV screen [8]. Electricity, which is normally taken for granted and hidden in walls, is used here as a material in the interplay with artistic artefacts such as a video image and the TV object.

The issue of 'normalisation' gives art and design an important role when dealing with an infrastructure which is mostly considered from a technical and utilitarian perspective. We can observe the *normalisation* process from the introduction of wireless communication infrastructure as a 'superstructure' - a fascinating technology available to only few and used for specific applications; to a 'cultural infrastructure' which is so deeply socially embedded that it becomes unnoticeable. As wireless connectivity is available almost anywhere at any time to anyone with a laptop or another Wi-Fi/3G enabled device, the connectivity is not any more in the centre of attention while its cultural impact becomes more and more significant. Although Campbell's work doesn't play directly with wireless signals, he sets the stage for artistic and design practices that examine *peripherality* of infrastructures.

Continuing along the "wired" line, the work "Live Wire" [32] by artist and engineer Natalie Jeremijenko brings attention to wired network infrastructure. The intensity of traffic within a local area network is rendered tangible through the 'wiggling' of a plastic wire suspended from the ceiling. Attempting to dispel the consensual hallucination of immateriality (of cyberspace)[33], "Live Wire" is an example of calm technology [68], operating at the periphery of our attention, while delivering information to our senses. "Live Wire" here bridges the discourse on (wired) infrastructures and (wireless) networks.

One of the first artworks that dealt with intangibility of wireless communications and its *architecturality* was Usman Haque's "Sky Ear" [25]. Conceived as an electromagnetic performance which engages both people and waves as participants, "Sky Ear" is an exploration of activity within the electromagnetic environment. Haque acknowledges intangible phenomena which "affect the way we related to space and to each other in much the same way that traditional architectural elements do - they make us move to certain parts of a building, … they condition the movements we make and how we make them and, through devices like mobile phones, … they have a direct impact on the way we associate with other people." [26]. By use of mobile phones for sensing and communicating at the same time, the changing colour of LEDs inside a floating structure of helium balloons interprets the interaction between us, the waves and the space in between.

Another project by Haque in collaboration with Bengt Sjölén and Adam Somlai-Fischer makes a significant contribution to the exploration of intangible infrastructures. Between 2006 and 2008 the trio developed the "Wifi Camera", an artistic tool to "reveal the invisible electromagnetic space" and "the shadows that we create within" [60]. The Single Pixel and Panoramic versions expose the information landscapes as seen by directional antennas [58]. The camera rotates and takes 'snapshots' storing networks names and signal strengths which it then renders into layered images. The images translate network activities identified in the space into a flat surface on the screen. "Wifi Camera" demonstrates physical properties of the waves at 2.4GHz wavelength (12.5cm), their reflections and interference. It uses waves in a similar way photographic camera uses light. Activity within different wireless network channels coming from laptops, Wi-Fi hotspots, smart phones and even microwave ovens is represented by the intensity of points in the image.

By 2007 household networks were a standard commodity; more and more of them were coming already encrypted. The project "Constraint City: The Pain of Everyday Life" by Gordan Savičić demonstrates the presence of encrypted private networks bleeding into public space of the street. Performed across numerous cities, this work addresses the "paradigm shift in the realms of everyday constraints, therefore the relation of abstract information layers to our everyday life" [51]. "Constraint City" reveals beacon frames coming from encrypted wireless networks, translating them into pressure of a corset on the body, causing pain to the person wearing it. The person can in this way "experience access-restrictions by walking through the streets", in a more palpable, less mediated way. It is "a pragmatic experiment in constructing ways of sensing relations that cannot be easily shared" [41], relations between pedestrian bodies and nearby wireless networks.

Unlike the practices described so far which focus on exposing and exploring existing wireless signals, "Hertzian Rain" by Mark Shepard is using wireless communication technology to distribute a participative ambient sound installation and generate interactions between people, environment and information. A network of wireless transmitters is covering an area in which people can receive the signals (sound) using a customized umbrella-receiver (wireless headphones connected to a receiver mounted on an umbrella made from EM shielding material). Both position and orientation of the receiver determine what is heard thus making a different composition for each person experiencing the work. In this way, "Hertzian rain" explores the physical

properties of electromagnetic radiation in depth, playing with the broadcasting range, shielding and filtering and rendering it *experienceable*. Shepard is asking the question on the extent "these Hertzian weather systems become as important, possibly more important, than built form in shaping our experience of the city?" [54] Created back in 2009, Shepard's work also tackles the important question of competition for signal dominance, a topic which is gaining importance in contemporary spectrum and bandwidth saturation.

One of the most playful visualisations of wireless signals was produced by Touch project team - Timo Arnall, Jørn Knutsen, Einar Sneve Martinussen in 2011. For "Immaterials: Wifi Light Painting" they created a custom-designed light rod with 80 LEDs. Holding the rod vertically they performed walks around university campus and took long-exposure photographs of the displayed signal strengths, creating in this way what they call "cross sections" of network signal strength. Or, as Arnall put it "a graph in real time. And in real Space" [4]. Although their initial interests were with the design of interactions with the wireless and NFC technologies, the Touch team focused more and more on revealing and representing the infrastructure and the intangible phenomena that have implications both for design and for the experience of products and spaces [42]. Even though the visualisations are static (generated once for particular space as opposed to changing with time dynamically) this work adds a playful parameter to the equation - the position of the light-stick. While they do simply visualise the amount of traffic passing through the university network, they choose the place and time to make their walks. Their process is similar to building mountains with Internet data.

The works by Berlin based artists Julian Oliver and Danja Vasiliev treat the networks from a perspective of affordance with a dose of irony. Infrastructure is critical. Part of the "Critical Engineering Working Group" these two artists take it as one of their goals to expose the underlying technological exchanges that take place within the networked systems we depend upon [45]. For example in "Newstweek" they question the vulnerability of contemporary media-defined reality revealing the different steps in data traffic. While this is important from the cultural perspective of news top-down distribution model and its possible subversion, it is at the same time relevant for spatial research as it reveals the materiality of data transmission from ISPs, servers and wireless access points to laptops and mobile devices that receive them. It emphasizes the locality of this traffic - enabling content modification with the physical space of particular network coverage.

6. THE ART, TECHNOLOGY AND HYPE

When we put these works in a chronological order, some patterns in the interest and the way to analyse electromagnetic environments emerge. Although not applicable to all, we could find a certain dose of romanticism in the early attempts to play with wireless network infrastructure. Revealing the information landscape [58] or affecting the way we relate to space with wireless communications [26] is a very ambitious task for an artwork. Whether or not and in what way floating balloons or images on the screen are able to really address these questions will be discussed later.

Furthermore, we can identify certain topical trends peak at certain times. For example, most of the artworks that were produced around 2008 measure Wi-Fi signal strength and react to it. "Immaterials: Ghost in the Field" and the "Under(a)ware" from "Sentient City Survival Kit", created around 2009, respond to RFID field. The more critical works which relied upon stronger technical skills from the artists are of a later date (Newstweek 2011). However, throughout this survey, playful interventions take central role and have the longest presence.

Could we blame these trends on general technical developments of availability of technology? For example, a Linksys router WRT54G was particularly popular amongst tech tinkerers and technically skilled artists. Besides its inexpensive price (60$ or about 45E at the time) the firmware for this router was particularly inviting to tinkerers as it was based on Linux components and released under the GPL licence preserving the source code available to public. Linksys open sourced the firmware for WRT54G in 2003. "In the two years since Linksys originally released the WRT54G firmware, whether by design or not, this affordable, common router has become not just a playground for hobbyists, but an open platform for commercial business as well." [69]. This set the ground for artistic experiments as well. It is around this time ("WiFi Camera", 2006) that the first artworks that used customized routers appeared.

With the release of 3G and 4G technology (around 2003 and 2010 respectively), faster connections and seamless integration between devices came about. This put off the attention from connectivity even more. "With the release of the 3G iPhone and Droid, location awareness was propelled into the mainstream." [18]. Asserting the issues of connectivity with a critical attitude thus became even more important and the language that developed around this practice spanned across a multitude of standards. For example the artworks produced around 2011 interpreted signals from electrical current, through RFID to wireless network signal strength and traffic.

Another interesting technical aspect of the artistic practice is the size and structure of the production team. While the first artworks involved quite a complex team structure and numerous external actors (the list of 25 people and several companies credited for Sky Ear confirms it[27]). In contrast to this, Newstweek, developed in 2011 was almost entirely conceptualised, produced, programmed (and even documented) by artists themselves. This change in structure and organisation of work can be due to the structure of cultural funding (artist with larger budgets have bigger teams, especially in the early media art scene), but it is also possible to relate to the increased availability of technology and proficiency some artists gained in the field during years of practice. What it brings along is a certain change of attitude and character of artworks. While both the narrative and aesthetics were more romantic in earlier artworks the conceptualisation and production are more sober and critical in the most recent artworks.

We could compare this development to the Gartner's 2013 Hype Cycle for Emerging Technologies [14] with the peak of inflated expectations manifested in claims such as to "lead to new aesthetic possibilities for life in an electromagnetic environment" [12], "give form to this space, to make visible the invisible" [25] or "Expose the invisible information landscape" and "Show how our physical structures are illuminated by this particular electromagnetic phenomenon" [58]. On the other end of our timeline diagram, "Newstweek" serves as "a tactical device for altering reality on a per-network basis" and intervenes in the "top-down distribution model" of news and facts in the vulnerable "strictly media-defined reality" [46]. This goal is not only attainable but also delivered by the artwork.

7. ARCHITECTURAL RELEVANCE OF ENGAGING WITH WIRELESS NETWORKS THROUGH DESIGN AND ART PRACTICE

Whichever strategy the artists used to tackle wireless communication – aesthetic or playful or critical – their intentions with reference to architecture vary. Some artworks like "Rebecca" or "Observatorio" engage in no explicit relationship with architecture (this is arguably false depending on our definition of architecture; the conclusion is derived primarily from artists statements). They focus instead on their source material – electricity or open Wi-Fi networks and use different image manipulation techniques to render them visible.

In contrast to this, "Sky Ear", "Hertzian Rain", "Wi-Fi Light Painting" and "Wi-Fi Camera" take thinking about space and the resulting overlay of electromagnetic signals as a starting point for their explorations. They investigate the physical properties of wave propagation in space - wave length, barriers, surface permeability and try to shape this as a material [26,54], using what we will call the *material approach*. "Sky Ear" explored the altering of shape and intensity of the electromagnetic landscape by both human and natural causes. Wavelength and reflections are demonstrated through their different reflection off of walls and windows. By the use of EMF shielding fabric on umbrellas in "Hertzian Rain", Shepard is enabling the audience to actively modify their electromagnetic environment.

Somewhere in the middle between these two we will find works that engage with wearable technology and urban tissue, "Constraint City", "Under(a)ware" questioning the intertwining realms of public and private when technology steps in.

Just like the intention, architectural relevance of the artefact which results from the discussed practices varies, although it can be somewhat implied from the intention. As for the "Constraint City" and "Under(a)ware" they function on two distinct scales – the urban and the personal. The wearable device is used to experience the overlapping territories of the physical and the digital, the public (street) and the private (body). The reference to architecture is not explicit here. However, these works engage with the complexity of physical networks which are part of a larger environment defined by architecture, offering a *personal wearable experience*.

We can observe that some artworks use architecture as a niche or a background, confirming its existent structure. For example "Live Wire" – a vertical string placed in a corner of an office, hangs suspended from the ceiling. With its 'wiggling' movement, it confirms the stable and static quality of this corner while its verticality invokes a typical architectural element – a column or a pillar. Further on, in their *reinforcing approach* images rendered using the "Wi-Fi camera" confirm the architectural structure of the interior where they are produced; they visualise wireless network traffic on top of and compared to existing architecture.

The "Bleeker Street Documents" plays with the base or grounding as an architectural element, rendering the dynamic change in network availability into a frozen morphology. Its *sculptural* value is evident but lacking a clear reference to the actual architecture of space under observation, there is not a significant contribution to the question of re-imagining the design of immaterial landscapes. Its main contribution is in the realm of aesthetics as it successfully delivers the feeling of digital while observing the geometry of shapes and shadows it is made of.

"Sky Ear" on the contrary exhibits both a visual and *structural relevance* to architectural experiment. It functions like an interactive 'ceiling' or a 'roof' made of and for wireless communication and physical objects (balloons, wire).

It is interesting to analyse from the perspective of architectural qualities the two works produced by the Touch team – the Immaterials "Ghost in the Field" and "Wi-Fi Light Painting". While both are using the same visualisation technique – long exposure photograph and both result in images of inexistent structures (the situation recorded on these photographs does not persist) the bubbly representation of RFID field has a somewhat sculptural quality while light paintings of wireless networks has a strong *structural relevance* to architecture. It resembles a wall, a barrier, a horizontal divider that can be 'uncovered' anywhere the team decided to make their walk. It reveals the connection between the two worlds – exposing for example the 'holes' in the network caused by nearby building's properties;

"No Network" is, like the light paintings, a *structural reference* to architecture. It is a metaphor and a manifestation of an empty space created by technology and for technology.

8. CONCLUSIONS

How can the presence of wireless signals be understood and treated architecturally? The artworks are naturally speculative in this respect, as their intention is mostly to raise awareness [54] or to demystify and render tangible [3,51,58] the presence and activity within the networks. Thus the relationship with the built environment is in a strong focus and highly important.

The works discussed here demonstrate the richness of the developing language that talks about intangible, insensible things that surround us. The reasons for this are simple; on one side, wireless communication became inseparable part of our everyday, crossing our living space in a multitude of ways. It becomes more and more relevant while falling deeper in the periphery of attention. Thus it becomes interesting for artists, designers and the technologically literate to translate this phenomenon into tangible experience. On the other side, technology has become more technically and financially accessible due to certain Open Source developments [69] and the general decrease in prices of wireless equipment. This too plays a role in the production of wirelessly inspired artworks and designs, affecting the size and configuration of teams, types of collaborations and the resulting complexity of artworks.

The more time we spent living with wireless communication infrastructure, the more familiar we got with it. This caused us to become even more ignorant to their existence [7]. We can recognize here a connection to Rancière's thoughts on the paradox of the spectator. "Being a spectator means looking at a spectacle" which is in Rancière's opinion the opposite of knowing or acting [48]. It puts us into a motionless, passive state lacking any power of intervention. Rancière discusses instead an active participation (in 'theatron'), epitomized by Brecht's epic theatre and Artaud's theatre of cruelty. Such active approach can be recognized, to a greater or smaller extent, in all of the artworks discussed above.

The work done in this field can be seen as a form of collective design research - the artists statements described above sound

close to research questions and deliver designs and interaction which is clearly capable of building on top of that.

Upon further analysis, we can see that some of these works clearly use the language of architecture to expose their 'findings', while others don't. How architectural is the intention, and how architectural is the resulting artefact? When thinking about this, one easily falls into the trap of comparing the artefacts to more or less standard architectural elements like walls, columns, ceilings, floors. While this can be useful to quickly illustrate their relevance, it renders both architectural and artistic output banal. Seen from this perspective, it becomes evident that the works discussed here are not able nor supposed to account for the complexity of architecture and experience of space. Attuned at "revealing" a hidden aspect of our environment, the artworks contribute to a language of hybrid surroundings we are embedding ourselves in. There is clearly a need to become more "fluent" in this language in order to better understand our habitat and its complexities.

There are two more lessons to learn from this discussion. Firstly, design research in the field of *wirelessness* can provide architecture with principles for design, construction and manufacturing which are more in line with physical properties and propagation of signals. This should result in improved building performance from the perspective of connectivity. For example the "WiFi Camera" provides a clear idea of the transparency of certain materials to signal propagation [61] while "Hertzian Rain" and "WiFi Light Painting" demonstrate the ability of material to filter the signal[4,54].

Finally, there is a promising discussion around shaping this "invisible" or rather "insensible" material. How could we play with its form and presence, and how can we treat it architecturally? Some of the above mentioned artworks give a hint about this and about the possible integration of the presence of wireless signals in conceptualising space and its use. Thus the works in the field of design and art succeed in opening a wider perspective on architecture, its' elements and their activation through the use of interactive technologies.

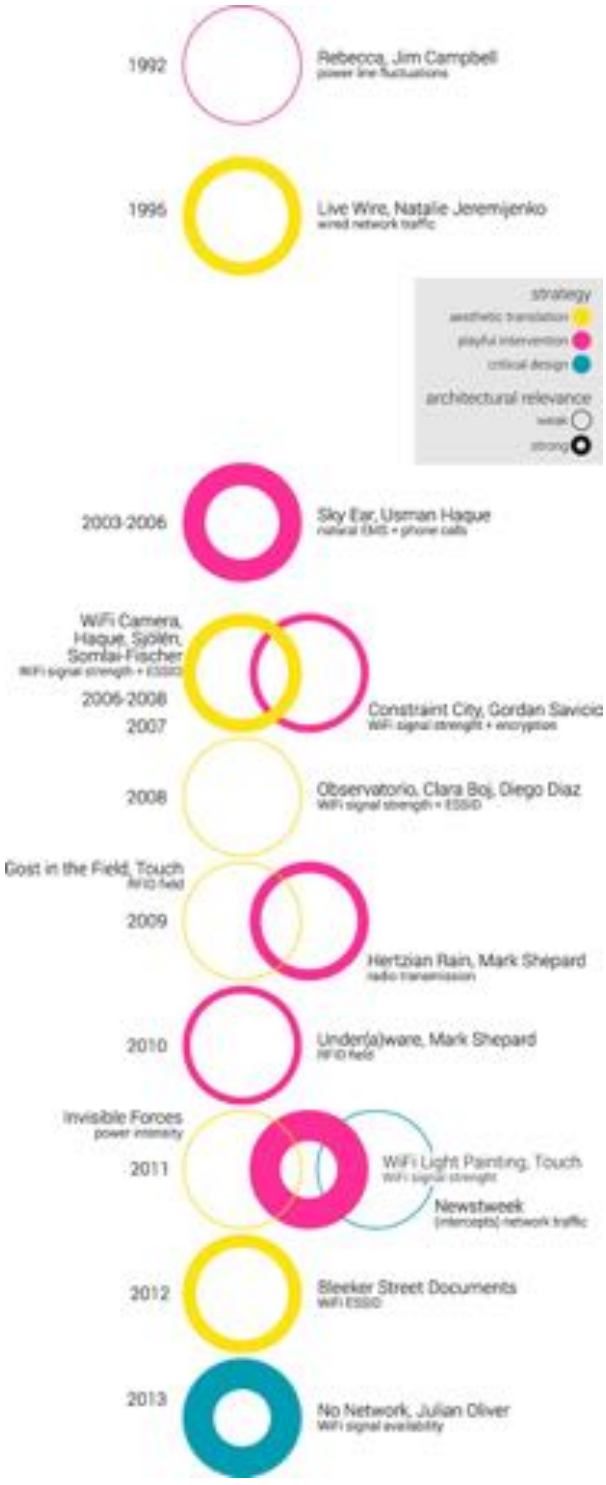

Figure 1. Timeline diagram offering an overview of artworks, with an indication of strategy (aesthetic translation, playful intervention, critical design) and architectural relevance (from weak to strong)

Table 1.1 Integral list of design and artistic practice exploring wireless media with brief descriptions.

"Portrait Of Rebecca With Power Line Fluctuations" [8]

Jim Campbell, 1992

playful intervention, minimal architectural relevance

Fluctuations of the power line become visible through an interaction between a portrait and a light bulb on a TV screen. Electricity, which is normally taken for granted, is used as a material in the interplay with artistic artefacts such as a video image and the TV object.

Reacts to: electrical power lines

"Live Wire" [32]

Natalie Jeremijenko, 1995

aesthetic translation, reinforcing approach

The use of (wired) network traffic is rendered tangible, while at the same time staying at the periphery of perception [9]

Reacts to: wired Internet (LAN) traffic

"Sky Ear" [25]

Usman Haque, 2003/2006

playful intervention, material approach, structural relevance

By use of mobile phones for sensing and communicating at the same time, the changing colour of LEDs inside a floating structure of helium balloons interprets the interaction between us, the waves and the space in between

Reacts to: natural EMS + phone calls

"Wifi Camera" [58]

Usman Haque, Bengt Sjölén, Adam Somlai-Fischer 2006/2008

aesthetic translation, reinforcing approach

Artistic tool to reveal the invisible electromagnetic space and the traces we create within. Exposes the information landscapes through layered images of network activity, using waves in a similar way photographic camera uses light.

Reacts to: Wi-Fi signal strength + ESSID

"Constraint City" [51]

Gordan Savicic, 2007

playful intervention, personal wearable experience

A performative tool that reveals the presence of private encrypted wireless networks in the public space of the street. It translates these abstract information layers into pressure of a corset on the body, causing pain to the person wearing it.

Reacts to: Wi-Fi signal strength + encryption type

"Observatorio" [6]

LaLaLab (Clara Boj and Diego Diaz) 2008

aesthetic translation, minimal architectural relevance

A telescope-like observation device which scans the space for Wi-Fi networks. Through a continuous observation, it generates a map of open wireless networks in the city.

Reacts to: Wi-Fi signal strength + ESSID

"Immaterials: Ghost in the Field" [2]

Touch (Timo Arnall, Jørn Knutsen, Einar Sneve Martinussen) 2009

aesthetic translation, minimal architectural relevance

Describes the field within which RFID tag and RFID reader will interact with each other in three dimensions, using long exposure photography.

Reacts to: RFID field

"Hertzian Rain" [54]

Mark Shepard 2009

playful intervention, material approach

Uses wireless communication technology to distribute a participative ambient sound installation. Explores the physical properties of electromagnetic radiation in depth, playing with the broadcasting range, shielding and filtering and thus rendering it *experienceable*.

Reacts to: custom RF infrastructure

"Under(a)ware" (Sentient City Survival Kit) [53]

Mark Shepard 2010

playful intervention, personal wearable experience

Explores different modes of coexistence of computing within the built environment. "Under(a)ware" is attuned specifically at alerting to the presence of discrete tagging technologies, rendering RFID readers into a physical vibration using of a motor built into the underwear

Reacts to: RFID field

"Invisible Forces" [10]

Anthony DeVincenzi 2011

aesthetic translation, minimal architectural relevance

Reveals the invisible electrical charge in objects using a sensor coupled with position tracking and generating a real-time visualisation of the electromagnetic field around charged objects.

Reacts to: electrical charge

"Immaterials: Wi-Fi Light Painting" [3]

Timo Arnall, Jørn Knutsen, Einar Sneve Martinussen 2011

playful intervention, structural reference / relevance

Long-exposure photographs of Wi-Fi signal strengths, displayed by means of a custom made light rod. Their process is similar to building a kind of light mountains with Internet data.

Reacts to: Wi-Fi signal strength

"Newstweek" [46]

Julian Oliver and Danja Vasiliev 2011

critical design, minimal architectural relevance

Questions the vulnerability of contemporary media-defined reality revealing the materiality of data transmission. It emphasizes the locality of this traffic - enabling content modification with the space of particular network coverage.

Reacts to: Wi-Fi network traffic

"Bleeker Street Documents" [31]

Peter Jellitsch 2012

aesthetic translation, sculptural approach

Transforms network availability into a three-dimensional sculpture representing signal strength, ping duration and network speed by height and position of peaks. A sort of romanticisation of a technical infrastructure through a narrative form of a diary.

Reacts to: Wi-Fi signal strength and traffic speed

"No Network" [44]

Julian Oliver 2013

critical design, structural reference

A mobile network jammer fit into a model battle tank, it ban access to the cellular (mobile) network creating a kind of negative space of connectivity which only emphasised connectivity elsewhere and our habit of being online everywhere, all the time.

Reacts to: GSM, 3G, Wi-Fi and other wireless signals

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Situations of Presence: Reclaiming Public Space In The Urban Digital Gallery

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ABSTRACT
The article considers the urban digital gallery as an opportunity to reclaim public space from digital factors of spatial determinism in the media city. It considers the affective quality of urban digital artworks as interface between 'human' and 'technology'. The urban digital gallery is proposed to contribute to media architectural discourse by establishing situations of presence through which public space might be reclaimed, re-inhabited and re-evaluated.

Categories and Subject Descriptors
H.5 [Multimedia Information Systems]: H.5.1 Multimedia Information Systems – *Artificial, augmented, and virtual realities*
J.5 [Arts and Humanities]: Architecture; Arts, fine and performance; Fine arts;

General Terms
Theory, Experimentation

Keywords
Media architecture, Digital art, Curating, Urban digital gallery, Spatial determinism, Affective experience

1. INTRODUCTION
The urban digital gallery is still a phenomenon of potential rather than an established concept. It denotes the integration of digital art with architecture and the urban ecology in more or less permanent installation structures. The urban digital gallery has emerged in the concurrency of a number of developments. It emerged in the aftermath of the artistic expansion of the territory of computation with the rising of "new media art," which in the spirit of conceptual art was a mixing of artistic categories, most of which were articulated in the 1990s, such as net art, digital installation art, virtual reality, interactive art, multimedia art, and mobile art. It follows a 1960s attention to the function of art as social intervention and a more recent alliance with urban regeneration programs, including explorations of technical urban infrastructures as exhibition platforms. It emerges in the aftermath of the architectural discipline's embracing of the information revolution of the 1990s, which also reflected a 1980s fascination with cyberspace and new immersive environments such as virtual reality. Paved away by modernist ideas of the building envelope as a thin, insulated membrane rather than a dense, solid mass, the technological turn in architecture also influenced postmodern orientations of deconstructivism, iconoclasm and abstract assemblage, which denoted a return to the façade in seeking new modes of reference and ornamentation in the building surface.

MAB '14, November 19 - 22 2014, Aarhus, Denmark.
ACM 978-1-4503-3302-3/14/11...$15.00
http://dx.doi.org/10.1145/2682884.2682893

The twenty-first century began with an almost nihilist disorder of things and artistic ideas in which digital art could continuously interweave discourses of fine art, digital culture, software and computation, architecture, urban development, academia and cultural production. The urban digital gallery emerged in this intersection as a platform that on the one hand has had to accommodate the new digital art forms technically; on the other hand it has had to find and articulate its contribution to the public domain. Today, the urban digital gallery has reached a state of establishment that urges us to question its role and contribution to the increasingly contested urban public domain in the media city.

A recently founded urban digital gallery that will serve as example in this paper is the SESI Digital Gallery, which takes up the three-sided façade of the SESI/FIESP-building on Paulista Avenue in São Paulo. The gallery was founded in November 2012 by Verve Cultural, Marília Pasculli and João Frugiuele. The SESI Digital Gallery is the first media façade in Latin America; it hosts tree to four exhibitions a year and is home to the annual SP Urban Digital Festival. The gallery covers a twenty-two-story Brutalist style high-rise, concrete building on Paulista Avenue in São Paulo. The building almost takes the shape of a pyramid, or a three-sided cone. It was built in 1979, designed by the then late Brazilian architect Rino Levi, who was an exponent of modern architecture in Brazil, in particular Brutalism that he adopted in the 1960s and contributed to the modernist transformation of the architecture of São Paulo around that time.

The urban digital gallery continues a tradition of artistic engagements with digital infrastructures of public displays in the public domain. This involved the temporary use of advertisement screens for art streaming. Up through the 2000s in particular, a curatorial practice emerged in this domain. These initiatives reveal a concurrency of interests, including artistic interests in activating the public sphere; interests by local governments to engage communities through public art practices; and city planners' interest in the role of art in urban

regeneration and city branding. The curatorial genealogy reflects a combination of aesthetic and strategic attention to the potential impact of media art on the urban environment, in a mode of 'reclaiming public space'.

2. RECLAIMING PUBLIC SPACE FROM SPATIAL DETERMINISM

We can trace this genealogy of reclaiming public space in The 59th Minute[1] initiative by Creative Time, which makes one of the first examples of art taking over an advertisement screen. Between 2000 and 2005 the MTV Screen in Times Square was programmed with moving images during the last minute of every hour. The Urban Screens[2] project initiated by Mirjam Struppek in Berlin in 2004/2005 continued and expanded this practice, however in a more strategic and coordinated manner, emerging from urban planning incentives. The replacement of advertisement with art on screens reflected an underlying aim of binding screens more to the communal context of the space, in order for the screen to facilitate the creation of local identity and engagement and contribute to a lively urban society. The curatorial discourse that guided these initiatives reveals a consideration of art to have an active role in affecting and improving the urban environment. We can see how this 'role' of media-based art in public space has been guiding recent exhibition initiatives such as the Screen City Festival[3] held in Stavanger in 2013, dedicated to reshaping public space through media art presented on the city's facades, shop windows and at urban venues. Another recent example, which also makes an example of one of the first permanent urban digital galleries, is the Midnight Moment[4] organized by Times Square Arts in New York City, which opened in 2012 and shows a moving image artwork across fifteen large, coordinated LED (light emitting diode) advertisement screens in Times Square, three minutes to midnight every night. The programming carefully considers the relationship between the art and the complex visual environment of Times Square[5]. Also the SESI Digital Gallery was founded with the purpose of establishing a new channel for cultural dissemination as an *integrated* part of the city, merging architecture, art and media through various exhibitions and events. The curatorial programming of the gallery carefully considers the public domain, for example by emphasizing artwork that is intuitive and easy to decode by a general audience; by prioritizing interactive artworks that are open, inviting and inclusive; and by prioritizing that the visual material somehow responds to the urban surroundings and to issues that are relevant in the urban context of Sao Paulo.

The aim of 'reclaiming public space' from advertisement content on screens, as literally formulated by the Urban Screens initiative, has been a kind of *raison d'être* for curatorial practice with media-based art in the public domain. It reflects a reformulation of the intervention tactics of the avant-garde, in particular the artist group the Situationist International, which was active from 1957-1972 and led by Guy Debord. The "counteracts" of the avant-garde were performed through tactics of *psychogeography* (drifting around in urban environments in order for the psychic and emotional experience of the city to blend), *dérivé* (purposely becoming lost in the city) and *détournement* (subverting the subordinate meaning of a place). These events served to reclaim public space from the controlling of space by political structures. The politically motivated aim was for these initiatives to counteract spatial determinism and for the individual to change the order and meaning of the city's spaces through changing his or her spatial behavior and emotional responses to the urban context.

The curatorial genealogy also reveals an underlying awareness of a culturally discursive resistance towards the visual dominance of space, which by the avant-garde was considered a visual discourse designed for manipulation and upheld on urban billboards and other mass media platforms. The visual layer of mediation is a factor that still controls our urban environment as a dominant of spatial determinism. Ever since the emergence of Critical Theory and Horkheimer and Adorno's critique of the culture industry and the manipulative nature of entertainment culture (1947), there has been a concern for the dominance of visual culture in public space. The critique concerns images of superficial cultural representation whose referents are not in the real world but in a symbolic layer – what Baudrillard termed *the simulacrum*. This is a situation in which reality and meaning have been replaced by symbols and signs to an extent where it is no longer a copy of the real, but the hyperreal (Baudrillard 2006). The metaphor of *the Spectacle* was introduced with Guy Debord's *Society of the Spectacle* (1968) to describe a society dominated by mass media consumption in which citizens were reduced to spectators. The image of the Spectacle was considered to constitute a deceptive visual layer in the city; alienating, inauthentic, and manipulative, as a passivizing symbol of capitalism. The public space of social communication, Virilio notes, is now replaced by a symbolic 'public image' (propaganda, advertisement etc.), with 'avenues eclipsed by the screen and by electronic displays' (Virilio 1994, p. 64) – soon enough "'vision machines', designed to see and foresee in our place" (Virilio 1994, p. 61).

When LED applications and other electronic displays were incorporated into the skin of buildings as an active membrane in the early 1990s, the spectacles enlarged in scale. The architect Robert Venturi noted how buildings had not only become sculptural forms that reflected light as a skin or layer, but it had come to determine one's perception of the city (Venturi 1996, p. 94). Media architecture is unavoidably a controlling factor of the human experience and valuation of space. It programs the sphere and changes the feel and order of the environment surrounding the building, as a visual, spatial dominant. The tendency of spectacularization is evident in recent media architectures of fashion brand storefronts, for example the façades of the Hollister flagship store in New York or the Chanel store in Tokyo, using architecture as iconographic communication surface for the purpose of influencing people's behavior to buy. While pushing "brandscaping," such constructions encourage a "public performance" of consumption and tourism and contribute to what Roy Coleman calls a mode of 'entrepreneurial urbanism' (Coleman 2005).

Digital aesthetics in public space play along a long-standing historical focus on the visible. Roy Coleman has pointed at the problem of social control today being strategically entwined with, and organized around, visualized spectacles that promote particular modes of behavior and ways of seeing urban space as celebratory. Ultimately, such spectacles lead to homogenization of public space (Coleman 2005, p. 132). They evoke Le Corbusier's vision for the control society of 'the radiant city', in which electric light was used to convert mute architecture into a living, communicative and controlling thing, which stimulated signals of rationality and rational design and became a

[1] www.creativetime.org/programs/archive/59/index.html
[2] www.urbanscreens.org
[3] The Screen City Festival was curated by Daniela Arriado and Mirjam Struppek. www.screencity.no.
[4] www.timessquarenyc.org/times-square-arts/moment/index.aspx
[5] See interview with Sherry Dobbin, curator of the Midnight Moment: www.urbanmediaaesthetics.org/#?cat=11_interviews?post=464_sherry-dobbin-director-of-public-art-times-square-alliance

controlling factor in the urban landscape. With brandscaping increasingly occurring in media architectural discourse, we need to question the visual-spatial determinism that the aesthetics of media architecture impose on public space. We need to question how these mediated urban "scapes" facilitate social relations and the production of subjectivity in the public realm.

The skepticism towards spatial determinism – the consideration of space (and its programming) as determinant in relation to the social – is deeply embedded in the curatorial discourse out of which the digital gallery has emerged. I would like to suggest that a significant *raison d'être* for the urban digital gallery is to make up with a control discourse; the spatial determinism of the technical controlling of space. The question is, what is the current critical matter of spatial determinism? If we consider the project of the avant-garde in a contemporary condition, from what form of control do we need to reclaim public space, and through what tactics?

3. SITUATIONS OF PRESENCE

Scott McQuire has noted that new forms of public interaction that facilitate qualities such as collective participation and unpredictable collaboration hold increasing social importance in an era in which public space is dominated by distributed technologies of surveillance and, in most cities, spectacular 'brandscapes' (McQuire 2008). In today's urban condition, the biggest thread to the controlling of space is not what is visual per se; it is the mediated urban layer that is *invisible*. While some urban centers are certainly challenged by the increasing density of digital billboards, such as New York and some Asian megacities like Hong Kong, Tokyo and Beijing, the technical controlling of our behavior in urban public space is increasingly characterized by invisible digital mechanisms of for example surveillance through GPS (Global Positioning System) and geo-tagging, privacy violations with Big Data, and sensor monitoring of intelligent and responsive technologies in architecture. Our current condition might not be that different from what Georg Simmel described with the term *blasé attitude*, as a response to Modernism and the overstimulation of the senses resulting from rapidly changing and contrasting stimulation of the nerves, which resulted in a retreat into inwardness (Simmel 1903). The sensorial challenges that Simmel traced in the metropolitan condition with electricity in the late 19th century, such as crowding, acceleration and over-stimulation, have gained new urgency in the media city. The blasé attitude of the 2010s is characterized by a human experience of social indifference and behavior of cocooning[6], isolation from others behind "bell jars" of digital information spaces, such as headphones, screens, Google glasses. These are mechanisms of the digital controlling of our urban spaces today.

People are not "present" in urban space. We have lost a sense of awareness, of seeing clearly. Andreas Broeckmann has described how symbolic representation, mediated participation and the equation of consumption and democracy have replaced a sense of active presence and involvement in public matters (Broeckmann 2004, p. 380). He notes how "Presence is the affirmation of an identity and of a Now in a specific medial environment." (Ibid.). It is our sense of presence that makes us understand who we are, how we relate to each other, how we relate to our surrounding environment, how we sense our agency and capacity for resistance; and which enables us to critically evaluate our ways of perceiving and sensing our being in the world. It is through "presence" we can activate our critical faculty and our capacity to act on the world and inhabit our cities as active participants.

Artistic urban interventions have a role in the public domain, I propose, which is to counteract conditions of cocooning and detachment from the social reality in the transparent media city. The project of reclaiming of public space is about reclaiming situations of presence. I will now exemplify how the urban digital gallery can contribute to a reclaiming of public space through programming of *affective* audience experiences that will establish situations of presence.

4. THE TACTILE IMAGE

When "switched on," the LEDs of the SESI Digital Gallery skin completely modify the architecture, and the ontological nature of the building changes. The Gallery dematerializes the appearance of the architecture, transforms its sense of shape, volume, stability, function and symbolism and creates an environment closer to virtual reality than architecture. The building that usually appears solid and permanent, and which would usually organize the surrounding material world in a solid and permanent way, is dissolved by references of a more symbolic nature.

The light turns the architecture into an affective capacity. Affect is the triggering of an automatic response in the body system. It is a physical reaction that takes place in the body, like an intensity, suspension or passion. It is not an emotion, which Brian Massumi notes has to do with subjective content and sociolinguistic fixing of experience (Massumi 2002, pp. 27-28). The affective "image" is a physical reaction that takes place in the body, which happens when the image (in this case the digital code) "touches" our bodies. Due to the "shock" to the corporeal system, affect is a possibility for shift of direction and for turning habits upside down (Massumi 2002, pp. 27-28).

The affective experience of the "image" of the SESI Digital Gallery is the experience of a structure of 26.241 LED clusters (pixels), installed on a façade area of 3.700 m2 with a resolution of 214 (vertical) x 167 (horizontal) pixels and a luminous intensity of 4,5 cd per cluster (See Figure 1). The rough-pixelated area is made of colored dots of a high switching rate, which we as audiences make sense of as an image. The LED clusters are installed in the building's original architectural skin made of a metallic honeycomb structure that covers the three-sided gallery. The particular nature of the image has two consequences in particular:

Firstly, because the LED clusters are dictated by the honeycomb structure, the image is not organized in a raster display; the mathematical, Cartesian coordinate space that has organized TV and computer screens up through history (Cubitt 2011, p. 25). Identified with both modernity and the broad cultural project of modernism, the raster grid became the technical protocol for the format of mass media representation (Krauss, 1986). The gallery screen deviates the screen protocol of most emerging new screen technologies, which are built on existing raster grid standards. This means to the audience experience that a different mode of visual decoding and sense making is activated. Secondly, since the audience is not presented with a glossy, high-res HD-simulating screen image, but one of very low resolution – and since people can never see the whole screen space at the same time as the screen is not taking up a rectangular space but "folding" around the building – one will have to "complete" the image herself. The audience

[6] The term "cocooning" was coined by the trend forecaster and marketing consultant Faith Popcorn in 1990 in her book *The Popcorn Report: The Future of Your Company, Your World, Your Life*, and describes the trend of insulation or hiding oneself from the normal social environment.

has to fill out the space missing in between the pixels, and to imagine how the image continues on the hidden side of the building.

Passers-by of the SESI Digital Gallery encounter a striking environment but may not know what to make of it at first. The façade's particular structure makes the image somewhat tactile. The experience of affect is produced through the way in which the digital code relates to our bodies. It is in this relation between body and code that an interface is established, in between the audience, the architecture and the urban-material layer, but also in between a physical and a virtual dimension, and between levels of physicality and bodily perception. The interface is the perceptual in-between-ness and becomes a facilitator of behavior.

Before I turn to some examples of different ways in which situations of presence can be established through the affective, tactile and embodied image, I will briefly turn to the specific urban environment in which the Gallery is located. I will do that with Broeckmann's quote in mind, stating "presence is the affirmation of an identity and of a Now in a specific medial environment." (Broeckmann 2004, p. 380).

The environment of Paulista Avenue in São Paulo, a busy and polluted business center representing the modernist urban project that in the 1950s replaced the original residential neighborhood, is unlike any other in the world because of what is *not* – advertisement. In 2006, the city's conservative mayor Gilberto Kassab passed a "Clean City Law," effective from 2007, which outlawed all outdoor advertisement. The law included a ban of outsized billboards and screens, even advertisement on the sides of buses and taxis, and the dimensions of store signs were regulated. The law was passed with the aim to combat pollution, in particular, visual pollution[7] As a result, São Paulo as a visual urban backdrop for the SESI Digital Gallery has no billboards, no flashing neon signs, no electronic panels, and no large LED advertisement screens. Although the fourth biggest city in the world, São Paulo's urban environment does not inscribe in a visual urban system designed for consumer society and ruled by capitalism. The city is left with an unmediated aesthetics without the illusory wrapping of advertisement as a layer of representation. This makes a very unique medial environment, one in which the invisible digital controlling of space becomes very literal. The gallery is not reclaiming public space from visual billboards, but from invisible factors of control.

The visual backdrop was particular significant to the experience of the Julian Opie-installation of *Promenade 3* (2013) (see Figure 1), which established a situation of presence through affirmation of meaning construction in a wider visual, culturally constructed world. Opie's work is known for his aesthetic style in the territory between art and graphic design, where he renders movement from the street and evokes the outlines of people in white line drawing, using minimal detail. Opie's work carries traits of Minimal and Pop art, of billboard signs, and sculpture. It questions the value system of representation in contemporary society. The visual language simultaneously employs a figurative image and a high degree of abstraction. It invites for reflection on how we engage with the visual world and its language of meaning. Installed on the SESI Digital Gallery, the Julian Opie installation dematerialized the building as an organizing construct and turned it into a figurative sculpture. The bright, white outlined people walking took up the full height of the building and made the building's shape seem almost invisible. The architectural shape "disappeared" with the black background behind the outlined people and came to appear incomplete, mobile and open-ended. The response that was activated in the audience was one of identification with the magnified human scale. In an almost banal but powerful way, audiences were reminded that humans are not subordinate to architecture. The large-scale, cultural-symbolic visuals was experienced as an interface into a sign system, part human and part abstract, which humanized the architecture through the mechanism of identification and made the city miniature, conceptually.

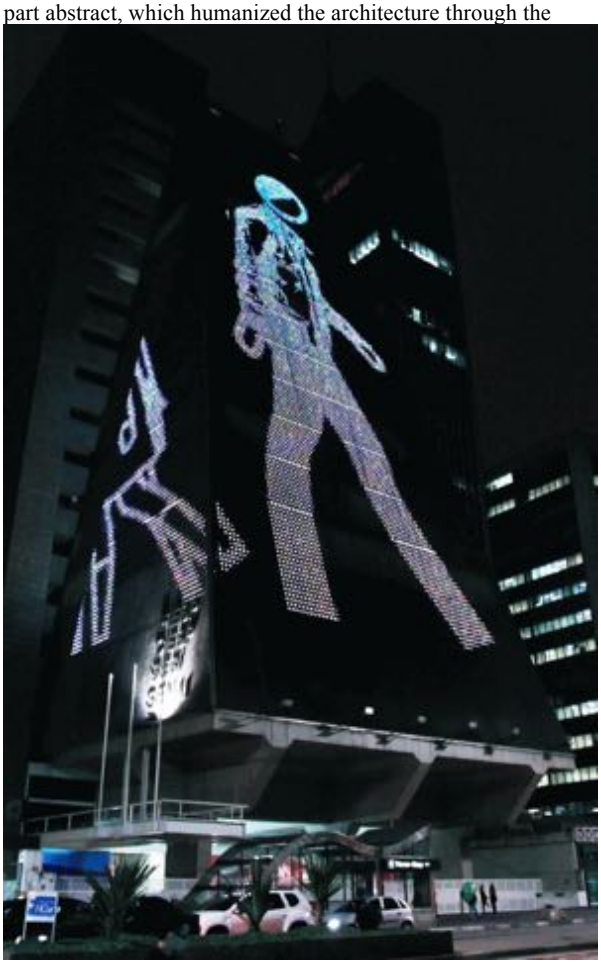

Figure 1. Julian Opie, *Promenade 3* (2013).

A different situation of presence was established in a mode of affirmation of a Now in the installation *Dancing in the Rain* (2013) (see Figure 2) by the two German artist groups Pfadfinderei and The Constitute. This was a site-specific, interactive installation for the "Brasil-Alemanha: Culturas Conectadas" exhibition in May 2013. The installation immediately suspended *habit* in favor of *experimentation*. People on the street were given illuminated umbrellas that functioned as "wearable light screens". The umbrellas worked as a tangible interface to interact with the light on the building façade. The shadows of the umbrellas were featured on the façade, which also showed a pixel rain and light storm. The order of nature was converted – the sky over São Paulo was clear, but the building showed rain and thunder. The pixel rain was blocked by the shadows of the umbrellas. What audiences would discover when playing with the umbrellas was that when

[7] Explained in the mayor's own words: "We decided that we should start combating pollution with the most conspicuous sector – visual pollution." (D.E. Harris, 2007)

the umbrellas were crossed, the weather on the façade would release thunder and lightning, and the colors would change. When no one was interacting with the work, the façade would show a steady pixel rain. The image in itself made little sense without the embodied participation, either from holding the umbrella or from identifying with the movements of another audience member engaging with the facade. The image was constituted in the body of the viewer, "framed" in the bodily experience of the image, as suggested by Mark Hansen in *New Philosophy for New Media* (2006). The installation invited people to feel empowerment through the chance to control the

Figure 2. Pfadfinderei & The Constitute, *Dancing in the Rain* (2013).

pixelated weather and through that modify the architectural façade. The physical and virtual environments became an inseparable whole, and the building became an aesthetic fabric of the audience. The moment of engagement produces an event composed of both live material of the body and live transmission of video and computer data on the façade.

A third installation established a sense of presence through participatory self-expression, by exploring a recent socio-technical phenomenon: the Selfie. *Selfie São Paulo* by Lev Manovich, Moritz Stefaner and Jay Chow worked with the building as an interface to contemporary digital culture (See Figure 3). The installation was part of the "Performance: Digital Expressions" exhibition in June 2014. It showed a live montage of individual Instagram Selfies from São Paulo, which were collected in a database, turned into data and sorted by estimated age, gender and degree of smile, extracted by the face analysis and aligned on the façade by eye compositions. The montage was animated over time as more Selfies were collected. The work built on the previous project *Selfiecity* [8] by Lev Manovich's research lab Software Studies Initiative, which compared Instagram Selfies from five global cities and which first set out to explore the Selfie as one of the most significant cultural-characteristic modes of self expression and social behavior in today's digital culture. The montage showed the diversity of São Paulo's citizens and offered audiences a chance to be confronted with their own curiosity for experiencing a few seconds of fame by potentially having their Instagram portrait shown on the giant façade. But the work also evoked awareness about a current social media environment in online networks and reminded that our spontaneous online actions are also sources of behavioral and cognitive data used for both commercial and surveillance purposes. 'The social' was explored as a new object of science and as a symptom of familiar, collective behavior in our present culture, and experienced through "shocks" of an image montage of high identification with the familiar Selfie poses. The installation exposed and amplified the social culture that surrounds and feeds the phenomena of the Selfie. It articulated the new public domain that connects physical urban spaces and the potential public sphere of the electronic network, while evoking ambivalent emotional responses in the audiences. People simultaneously celebrated the exhibition of their portrait and were confronted by the threat of public exposure (like in social networks, just bigger and in public).

Figure 3. Lev Manovich, Moritz Stefaner and Jay Chow, *Selfie São Paulo* (2014).

These examples demonstrate a role for art in the contemporary media city, which Scott McQuire has noted should be "…not as the belated response to an already existing social world, but as an integral part of the construction of social relationships." (McQuire 2008, p. 149). The SESI Digital Gallery invites for participation by heterogeneous groups, business people, skaters, homeless people, and tourists, and brings strangers together. People may stop to consider and engage with the installations, forming into what Richard Sennett has termed a 'genuine public encounter' (Sennett 1977). The gallery offers audiences, invited as participants, the ability to intervene temporarily in the public space and its architecture, and to "feel" an entry point into a collective situation of contemplation.

5. OVERCOMING THE TECHNICAL

A challenge of reclaiming public space through urban digital art is the *technical* aspect of the digital image; the fact that the image of code is cold, calculated, and something that orders and sometimes alienates our human relationship to the world. The picturing of many science fiction movies of how the technical is reproducible and evokes associations with automation and the machine, of which we humans might eventually loose control, is deeply anchored in our fear of technological determinism. Also the "media material" of urban digital art has been interrogated for its technical nature, its reproducible material, and its underlying logics and forces of calculation, reason, and mechanical production (Weibel 2006, p. 3), and re-production, which undermines its authenticity.

But as Mark Hansen reminds us, we are not separated from technological space (Hansen, 2006). At some point, we will need to overcome digital dualism and realize that the digital and the physical are increasingly meshed, that they dialectically co-construct each other – which is already an accepted principle of augmented reality. Our reality is both technological and organic, both digital and physical. It is additionally important to note that audiences are driven into physical engagement with the digital image while being aware of their own participation in the production of the image. They are aware of the staged

[8] www.selfiecity.net

situation, their physical interaction with the responsive façade, of their own participation in the production of the image. This means the audience cannot blindly receive information, but they perceive and evaluate according to how their optics and bodies are prepared in the specific context and time.

6. CONCLUSION

The urban digital gallery, as a phenomenon of potential rather than an established concept, is in a constant state of change while adapting to new code, technologies and artistic visions. The appearance of the architecture changes with the art and its artistic intentions, questions and technological means of execution, and not least with the audience's curiosity and modes of engagement. This means that while still fixed in space, the gallery is not fixed in perception, meaning or discourse. In line with the philosophical position of Henri Bergson, the ontology of the building comes closer to one of "becoming" than "being" (Bergson 2009/1911).

The urban digital gallery constitutes a new mode of urban intervention that alters the dynamics of public space. It is a domain of duration through which we can challenge spatial determinist discourses in media architecture and in the media city at large. Many artists work with the same local site over time, exhibition after exhibition, and the gallery comes to work as a form of urban catalyst. Of course, these interventions are not permanent and we cannot yet prove any artistic impact, but the continuous re-appearance of artworks and re-activation of the media architecture will change people's perception and expectation to what they may encounter in public space. What this is all about is our capacity to adapt to (or resist) the spatial complexity of the media city, in which people grow accustomed to continual abstractions. If nothing else, the urban digital gallery serves as testing ground for ways of curating situations of presence through aesthetic experience.

The main potential of the urban digital gallery, I argue, is not one of bringing enlightenment to the audience or simply making visible the invisible, underlying forces of power in society. There is a role for digital art in destabilizing the control society, which has long been an aim of the arts but which digital art can perform in direct dialogue with the very visible and invisible infrastructures, facades and media platforms that make factors of spatial determinism today. The urban digital gallery is a site of potential agency; a media architectural phenomenon that holds the potential to give the media façade a critical role in the shaping of today's urban environments. It reflects what Lewis Mumford believed from his analysis of technology's social embeddedness in our societal development, that true technological progress in society would happen in a dialectic process *between* the material of the city and the symbolic, abstract ideas level (Mumford 1971). It matters greatly what emotional realizations we seek to activate in the public through the symbolic, and with what tactics.

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Designing with the Immaterial

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ABSTRACT

As a knowledge based practice UNStudio's approach is to link the practical experience within the demands of the global building market with a soft conceptual design and research approach, through which innovation constantly feeds back into and effectively interlaces practice with theory. UNStudio's approach to media content has developed into a tool that serves the purpose of enhancing specific qualities and architectural design parameters in order to add a communicative layer. The immaterial technology within the design is however not an isolated design task, but one of many design components, and therefore an integral element of the architectural system. The application of technology is understood to be similar to the computational methods that UNStudio employs as tools for designing, rather than generating design. Providing examples of this approach on different scales serves as a methodology for the investigation and underlines the process as a thread for the development of the design work, rather than merely presenting the results thereof.

Categories and Subject Descriptors

J.5 [Arts and Humanities]: Architecture

General Terms

Design, Experimentation, Human Factors.

Keywords

Immateriality, multiple scale levels, communication, media control systems, integrated lighting, architectural design knowledge, after image

1. INTRODUCTION

In Stanley Kubrick's 1968 film '2001: A Space Odyssey', the opening scene takes place at dawn in prehistoric Africa, in a barren landscape populated by primitive apes. The visual narrative then skips the multiple centuries between and shifts suddenly to an image of outer space, with the apes now replaced by human astronauts floating above the Earth.

MAB '14, November 19 - 22 2014, Aarhus, Denmark. Copyright is held by the owner/author(s). Publication rights licensed to ACM.
ACM 978-1-4503-3302-3/14/11…$15.00
http://dx.doi.org/10.1145/2682884.2682893

With this sudden shift of context Kubrick leaps from past to future and in so doing creates an acute awareness in the viewer that they themselves are firmly positioned in 'a present' somewhere along an evolutionary line that the film maker does not need to detail.

This technique is the privilege of all storytellers, whose craft affords the freedom to manipulate the sequence of a narrative that unfolds over time. We refer to it here however because '2001: A Space Odyssey', by its very nature and intention did not present a traditional story with a beginning, middle and end, but was instead an abstracted narrative that Stanley Kubrick himself famously described as being open to (if not reliant upon) interpretation:

"*You're free to speculate as you wish about the philosophical and allegorical meaning of the film—and such speculation is one indication that it has succeeded in gripping the audience at a deep level"*. He later states, "*Yet there is at least one logical structure—and sometimes more than one—behind everything that happens on the screen in "2001.*"[1]

If we use this cinematic analogy to refer to the evolution of the media facade in architecture, then the obvious question that first arises is, 'where are we now?' Closely followed by, 'where are we going?' Which inevitably leads to, 'what current developments are we seeing in contemporary media applications to buildings and do these developments predict a determinable future? If so, what might this future be?'

But it also brings into question the potential effects of the application of media technologies to buildings, how these are received and interpreted by the user and how these facets of visual and cognitive interaction can be guided by design for varied but specific purposes. In architecture there is also after all '*a logical structure behind everything that happens*'.

Furthering this filmic reference - and as was the case in Kubrick's movie - visual technology and special effects are commonly used in cinema in order to create believability (and conceivable fantasy) of the pictured environments. Technology in cinema is of course primarily used as a tool to enhance storytelling and not as a means to place focus on the applied technologies themselves. The same can and should be said of today's media facades: neither the technology itself, nor the materials selected to house and shape its effects convey the actual story. The real story is communicated through the immaterial effects created by the merging of these individual elements. It could therefore be argued that if it is required that building envelopes and parts of buildings represent and convey a certain message, then the immaterial layer of media is most strongly perceived when integrated holistically into the design. Furthermore the expression of a building becomes explicit when its communicative layer contrasts with the surroundings and when technology is not merely applied, but is moreover adapted to enable specific material and immaterial effects.

In this paper we will therefore introduce a number of examples of past and present UNStudio projects, which chart our investigations over time into the potential for the integration of material and immaterial communication during the design process.

1.1 Tools are Everything

"How can you develop a new, fully integral way of making objects? [….] The most important thing is to filter and to edit. The computer is so rich; you have to use it as a clever editing tool. We [as architects] have to make our choices, learn and think. We have to develop new concepts of control, not a linear system, but contemporary techniques that think of relational compositions."

Ben van Berkel [2]

Within the design processes of a range of projects at UNStudio, we became increasingly aware of opportunities to not only integrate materials in innovative ways into our architecture, but also of ways to extend material testing through the addition of immaterial layers. The intention to add a layer of communication to the architectural design originated from the aspiration to make buildings with a traditionally commercial background more accessible to the public and to trigger a form of interaction with potential users. If related back to 'storytelling', this communication layer could in fact be described as non-human, non-verbal yet heavily reliant on the technologies applied. To date these have involved electronics, software coding, material choices and a hybrid combination of materials.

At UNStudio the layer of media is conceived in the design conceptually and strongly relates to the programme inside the building, the activities in the environment and the urban context. In the scale of building components this media layer is relational to other material and immaterial aspects and is foremost the subject of the user's perception, which relies heavily on our current understanding of physics, psychology and visual perception. Several ways to interpret this layer have been tested throughout UNStudio's body of work, with Ben van Berkel and Caroline Bos describing the concept of the "After Image" as one way of integrating communication.

"Literally, the after imager refers to the lingering visual impression that is caused by intense or prolonged stimulation of the visual retina. To us, the after image means something slightly different; we use the notion to include the entire scala of sensations and perceptions caused by intense impressions." [3]

Two temporal dimensions thus become relevant for the viewer: the moment of perception "the experiential dimension" and the enhanced "after perception".

Our society is slowly moving towards an economic model defined by the term 'Collaborative Economy', wherein ideas of communication and sharing dominate the meaning of trading, selling and buying. Within this economic model sizes, quantities and dimensions are dissolved and the concept of privacy is revolutionized. Collaborative tools therefore become an essential device with respect to how we relate to all that surrounds us and make the communicative media layer essential to make a new architecture explicit - bringing it from the age of computation and hardware to a collaborative, social media age. The collaborative therefore anticipates the idea of interaction between the moment of perception and the after effect.

2. AN ANALYSIS PREPOSITION

Scaling, after effect and process

Our method of investigation in this paper is one of self-analysis. We have therefore identified two analytical instruments that will guide us through the definition of the case studies: the scalar approach and the intangible asset of communication.

A scalar approach is used in this paper to compare quite distinct projects in the work of UNStudio and highlight within these the various aspects related to the type of immaterial design drivers: the story to be told by the project, the methodology and collaborative aspects, as well as the relationship between the typology and the semantics of communication.

The design of the immaterial dimension previously defined is an intangible quality, non-descriptive. It is a uniquene level of communication that dematerializes the design, causing it to belong to a whole new series of adjectives, situations and motives.

3. CASE STUDIES

Building design strategy focusing on optical illusions and effects created by a repetitive strategy of modular design products developed in 1:1 prototypical scale

The following three examples of realized retail projects illustrate UNStudio's design approach to this typology over the years and how immaterial aspects have increasingly become integral ingredients of the overall design concepts.

Between 2003 and 2013 UNStudio designed a series of retail and leisure projects in different locations in Asia that in one way or another each addressed the immaterial aspects of the façade envelope through different design solutions. Common to each design development was the geometrical iteration of modules that create different optical effects during day and night. Because the media was treated as an integral element of the architectural design and was not simply applied to the building as 'added on' technology, it was possible to achieve night time effects through controlled lighting that obfuscate the scale of the buildings and offer a canvas to the public that adopts a subtle approach and is not based on commercial exploitation. These night scenes instead add another layer to the building, tell the story of what is going on inside and most pertinently, underline the unique identity of the building, thus contributing to the public realm.

The designs play with the scale of the urban environment and at the same time make explicit use of content that is reproducible at the scale of a home screen. The dimension of the operation creates a freedom of dimensions and brings the scalar dimension of the building to a small and a big size simultaneously.

The content displayed varies, with the ever changing resource displaying communication that is time appropriate. As the content evolves with time and the programmability of the images displayed is flexible, it produces a message that is always capable of corresponding with the time frame and the dynamics of its surroundings. The image portrays a moment of the design: an effect that allows us to reconnect with the visualization of the design through recognition. In the moment that the image displayed changes, it also changes that individual recognition of the image of the building itself and its aftereffect diminishes.

3.1.1 The Galleria Department Store, Seoul

The Galleria Department Store facade renovation began in 2003 and the building re-opened in September 2004. Its screen became

an attraction in the center of Seoul, largely due to its abstract and atmospheric content, which presented a contrast to the more typical advertisement media screens. The idea behind the façade testing and chosen materials for the 4330 glass disc cladding was to ensure that the discs would appear opaque during daytime but would allow for manipulation through architectural lighting at night. Each glass disc is backlit and illuminated by one singular LED fixture with a custom designed lens and is animated by means of a software controlled system based on pre-programmed images, which display different moods and atmospheres.

3.1.2 Galleria Centrercity, Cheonan

A few years after the completion of The Seoul department store, the same client commissioned UNStudio to design a new department store building in Cheonan, Korea. The typology of an approximately 66.700m2 large department store was re-investigated when starting the design for this new shopping plaza and we began to see these public functions as key elements in making the project more a space for collective experiences than simply a commercial building alone. This resulted in a building organisation with a central void space that was linked to public plateaus, which in turn linked at different levels the day-lit leisure areas of the façade with the central void space and vertical circulation.

The façade is based on a double skin principle, combining a closed back wall system, which is exchanged only at the public plateaus through a transparent curtain wall, with the transparent outer layer. Both layers have vertical mullions, which are designed to create a Moiré effect. The mullions are static, but follow a geometric pattern, so when the viewer moves around the building, the waves - starting off at the plateaus - flow around the building's façades.

Figure 1 Diagram day and night appearance of façade.

The lighting design concept for the Galleria Centercity in Cheonan aims to make the building virtually disappear at night, whilst the content of the lighting animation simultaneously display themes related to the programme inside the building. When we started working on this concept we built a 1:5 model in our office in Amsterdam in order to study the proportions and the Moiré effects. We further experimented with lighting within the cavity of the double skin glass facade. In collaboration with lighting designers AG Licht, the fixtures and a system of projecting from the mullions on the outer facade layer towards the back wall was developed. The lighting fixtures were designed to be integrated into the vertical mullions (triangular shaped profiles) to avoid unexpected shadows and to define crisp vertical mullion lines on both layers of the facade. In a mock-up on site these vertical mullions and the means to suspend the outer mullions from the back wall were tested while construction of the main structure was ongoing. Colors of glass and profiles, the effect of the double layer and facade ventilation were tested alongside the wave like optical effects. Zumtobel produced the lighting fixtures for this project; whilst with AG Licht and Lightlife we worked further on the content of the media design and choreographed a library of videos referencing all possible events that could serve as a database for different programmed scenarios. All of these animations aimed to use just a portion of the LED fixtures in order to suggest an obscuration of the building's form, whilst instead the animated visuals tell an abstracted story of the building.

3.1.3 Hanjie Wanda Square, Wuhan

Hanjie Wanda Square is a luxury shopping plaza located in the newly erected Wuhan Central Culture Centre. Following a competition, UNStudio's overall design was selected by Wanda as the winning entry for the Hanjie Wanda Square. The façade design focuses on achieving a dynamic effect, reflecting the handcrafted combination of two materials: polished stainless steel and patterned glass. These two materials are crafted into nine differently trimmed, but standardised spheres. The geometry ranges from full stainless steel spheres to a sequence of gradually trimmed spheres down to a hemisphere, with an inlay of laminated glass with printed foil. The spheres have a diameter of 600mm and are mounted at various distances on the 900 x 900mm brushed aluminium panels, which were preassembled and mounted on site.

Figure 2 Façade modules.

The façade employs 42.333 of these spheres, systematically distributed to create a larger scale pattern at the façade surfaces. The architectural lighting is integrated into the spheres. Within each sphere LED-fixtures emit light onto the laminated glass to generate glowing circular spots. Simultaneously a second set of LED's at the rear side of the spheres create a diffuse illumination

on the back panels. A total of 3100000 LED lights where used to cover the 17894 sq.m. media façade. Various possibilities to combine and control these lights allows diverse media lighting effects and programming of lighting sequences related to the use and activation of the Hanjie Wanda Square.

3.2 Future Screens / the Component Research

Urban Strategy for the Integration of Screens in Public Spaces
UNStudio, in collaboration with the research group Interactive Public Spaces of the Amsterdam University of Applied Sciences (HvA), is currently carrying out research into the application and design of media screens for use in outdoor public spaces. Public space is a social form of physical space that exists in various forms within the urban fabric. It can be defined as a connecting space, where people come to a common understanding and shared social experience.

Following a need expressed by the outdoor media industry for the acquisition of assignments which would make a valuable contribution to outdoor space - for example to influence safety or social interaction – UNStudio joined forces with the research group Interactive Public Spaces of the HvA to develop public screens with various possible applications. To date public screens in the Netherlands have been used primarily for advertising purposes, however there are numerous further possible applications. Outdoor media companies in the Netherlands often experience cultural sensitivities relating to public screens from municipalities, managers of public spaces and from the public. However initiatives carried out abroad demonstrate that public screens can in fact make a positive contribution to public space. The Dutch situation is seen to be unique and therefore requires tailored research and innovation.

The objective of the research is to create outdoor media screens with added value for public space. The scale of the research is dimensioned to the screen itself but does not portray a final dimension or content. It examines the role that media screens can play in supporting the needs and activities in public spaces of both individual organisations and the public. In addition, valid operating models are being investigated for media screens, which are not designed primarily for marketing purposes. Small and medium-sized enterprises, student and faculty researchers are collaborating on applied research through pilot projects and user and literature-based investigations in order to address the above mentioned issues.

The overall goal of the project is to develop the public screen concept further and to add interactive social value to public spaces. The communicative dimension investigated is therefore social. This concept and its content needs to be economically viable and aesthetically attractive for both the general public and possible customers. The role of UNStudio within the research group is to focus on the typology of public spaces and to define activities and requirements associated with these. UNStudio will also help to identify possible locations based on shared typological characteristics from the researched public spaces. The research work is undertaken in collaboration with students, researchers and interactive media companies.

UNStudio supplies knowledge to integrate public screens in the built environment and supports in the designing of a future media screen. According to the project structure the consortium members contribute technical expertise and media content for the design guidelines.

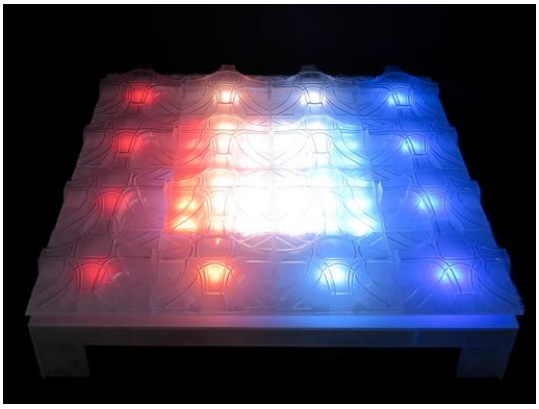

Figure 3 Prototype Future Screens.

Figure 4 Prototype Future Screens.

3.3 VI Palazzo ENI – Urban Informatics & Social Awareness

Urban strategy to create social awareness through informatics by reflecting a building's energy consumption in order to initiate a more self-conscious neighbourhood
The communicative layer within the design of the office complex for the energy multinational company ENI, underlines three complementary systems: the façade skin, the "digital lung" media display at the lobby of the building and the energy dashboard. The dashboard is software that employees can individually use to interact with the building and that results in the content being displayed on the media façade.

The users of the building belong to a part of the ecosystem. This ecosystem consists of interconnected parts that include instruments and urban dynamism within the urban tissue.

A set of strategies aims to improve the quality of life and work for the user of the building complex. The solutions, intuitive and engaging, help the users to reach and obtain a more productive and sustainable approach to working life.

A group of ‘smart systems’ facilitates working life in terms of mobility, energy and health via a ‘dashboard’. The solution is integrated and therefore does not have a unique scale but is pervasive and omnipresent.

The energy gain and consumption of the building are displayed on the façade during the evenings and at night as a social status (Figure 5), which improves the relationship of the large scale office building with the small-medium scale of the neighbourhood housing buildings.

Figure 5 Urban Informatics, display percentages of the energy usage or energy gain of the building.

The positive and reassuring feedback that the building communicates to the passer by or the neighbour resident further strengthens the validity and the sustainable image of the company ENI - a giant within the energy industries - by displaying the real life data of the office block which has been designed to achieve a Zero Energy building. The mantra ‘control, comfort, action’ encourages the users to visualise and therefore modify their personal patterns in terms of energy consumption and efficiency.

The Energy Dashboard (Figure 6) activates the systems of control within the design, encouraging the individual user to take control and monitor in real time the energy equation of the building, while enabling control from a distance of their own work space and electric appliances. This further enables the monitoring of the CO2 carbon footprint of the building and favours social interaction and the values of community.

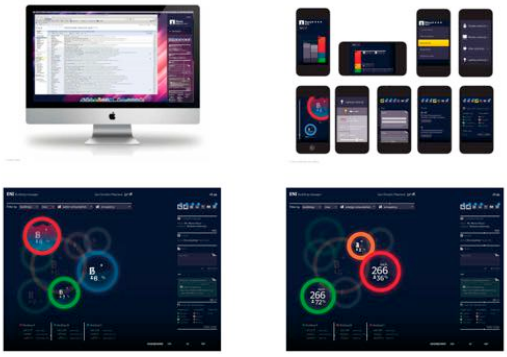

Figure 6 Building System Information System.

The “digital lung” - the large display installed on the roof of the main lobby - displays the energy usage of the ENI network in terms of performance and sustainability, quantifying numbers of extraction dwells, CO2 emissions, financial indexes, energy production of the ENI network and of the building itself. The “digital lung” therefore displays data to visitors, adding to levels of communication and encouraging social awareness about the built environment and the use of energy in the surrounding architecture.

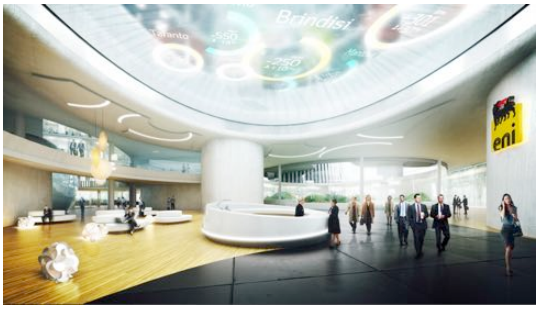

Figure 7 Digital Lung

3.4 Hanwha Headquarters - remodeling

Building design strategy to improve performance of building envelope and balance environmental aspects both internally and externally

UNStudio’s design for the Hanwha headquarter building incorporates the renovation and remodeling of the facade, the interior of the common spaces, lobbies, meeting levels, auditorium and executive areas, along with the redesign of the landscaping. Several important variables were required to be incorporated into the redesign, most essentially the surroundings, nature and the environment.

UNStudio’s concept for the project resulted in the design of a responsive façade, which prioritises and integrates groups of key parameters: programme (exterior and interior), indoor climate and environmental considerations. The existing façade contains horizontal bands of opaque paneling and single layers of dark glass. In the remodeling this is replaced by clear insulated glass and aluminum framing to accentuate views and daylight. The geometry of the framing is further defined by the sun and orientation factors to ensure user comfort inside and reduced energy consumption. The basis for the facade expression is largely formed by the programme. By varying the placement of the façade panels a variety of programme-related openings are created.

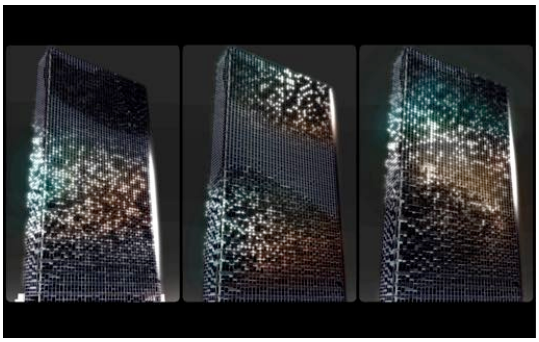

Figure 8 Façade variations

The North façade opens to enable day lighting within the building but becomes more opaque on the South façade, where the sun would otherwise have too much impact on the heat load of the building. Openings within the facade are further related to the views: opening up where views are possible but becoming more compact on the side adjacent to the nearby buildings. Direct solar impact on the building is reduced by shading, which is provided by angling the glazing away from direct sunlight, while the upper portion of the South facade is angled to receive direct sunlight. PV cells are placed on the opaque panels on the South / Southeast facade at the open zones where there is an optimal amount of direct sunlight. Furthermore, PV panels are angled in the areas of the facade where energy from the sun can best be harvested.

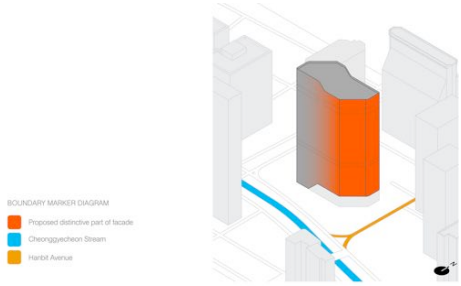

Figure 9 Diagram Façade.

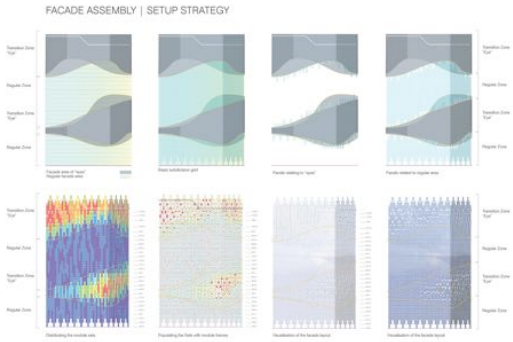

Figure 10 Façade Element Distribution Diagram.

The facade is animated by individual LED pixels, with dynamic lighting reflecting different parts of the building and highlighting areas of activity within. Currently in the final design phases, this project is more perceived at night time through subtle contrasts between lit and un-lit areas, taking into considerations also lighting from the interior working areas to be visible and integrating this daily variation with 'sparkles' of light added to the framing that are in balance with the energy harvesting strategy of the building envelop and express an interdependency between daylight and artificial lighting.

3.5 Capsule GOW

Design strategy between physical and virtual perception
UNStudio's 'Nippon Moon' giant observation wheel was designed to create a journey in which learning about the environment, culture and one's individual part in this is central.

Figure 11 Nippon Moon, GOW, visual.

Four key elements define the logics of the socio-architectural design; enhancement of the senses, interactivity, experience and romanticism. Through the integration of interactive design elements a virtual world was created in which the visitor becomes part of the social network, which revolves around the GOW.

Figure 12 Double Height Capsule, Nippon Moon.

Discovery, the Ride and the Return are three chapters of the design, which contribute to attracting visitors and to the stimulation of the imagination. The Nippon moon app is designed as a strategy for a user-experience interface that can be installed on smartphones and tablets. During the ride, this accessible software makes it possible to communicate with people in the other capsules. In addition, the possibility to enhance the senses through the incorporation of augmented animations or sounds helps to focus the experience of the visitor.

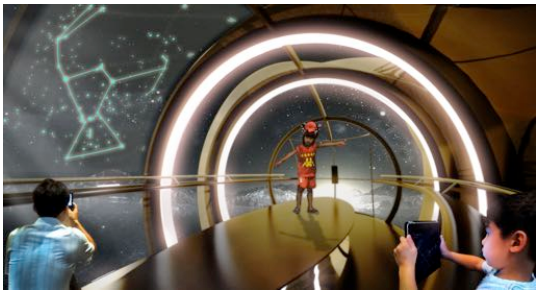

Figure 13 Augmented reality Screen, Nippon Moon.

The app also enables the visitor to switch from reality to digitally altered views from the capsules, which are created through augmented reality techniques in the transparent skin of the

capsules. The reality of the surrounding is over-imposed with virtual reality, dissolving the information of the past with the one of the future: analyzing the star constellation or the flight path as well as showing the changes within the landscape and the seasons and zooming into the surrounding elements to achieve more information.

The capsule of the Nippon Moon is scaled to its users. The app and the screen sizes define the capsule as a product where the scale relates extensively to the human scale. Therefore varied design studies have been undertaken in the dimensioning of the capsule to propose a differentiation of uses: a child with a higher pedestal, a change of the handrail to be held with two hands, for instance, for couples.

4 CONCLUSION

From Practice to Theory - what happens next?
Early media facades investigated the potential to create urban effects and building identity through the use of innovative material choices and somewhat basic animated content. Their elegance was perhaps to be found in the holistic way they approached branding, which starkly contrasted with large advertising boards and high density media screens that dematerialise the architecture that supports them and render it somewhat irrelevant after dark. More recent developments however, have seen a layer of functional intelligence becoming an integral part of the building's skin and adding the possibility for varied means of communication with both the user and the surroundings, thereby blending the scalability of the design intent. For the architect the integration of a media layer into an architectural project affords the possibility for the communication of ideas and concepts when these are relevant and desired for the design of a project. As shown by the examples we have included in this paper, an added layer of meaning can be conveyed through the use of subtle tools and/or project specific data input. This addition therefore adds aesthetic and performative parameters to these projects. In this way digital communication becomes choreographed and aligned with the architectural design. But what does the future hold? In some cities recent years have witnessed a proliferation of media facades of all shapes and sizes, often competing for attention with their glistening neighbours and in so doing perhaps not only negating what was once their more subtle appeal, but also running the risk of creating architectural versions of Times Square the world over. We believe however, that this initial enthusiasm for all that glows is beginning to evolve into a more intelligent layer within architecture and one which offers the potential for more meaningful and versatile communication. This immaterial layer however, relies upon an understanding of how the 'image' of a building is perceived and the possible visual and cognitive reception of the information and effects that are applied. Built experiments have taught us that users begin to interact with such architecture in unpredictable ways. Often the delineation between what is material and immaterial becomes blurred as virtual and real identities merge. This has meant that media in the broadest sense has become one of the key drivers for story-telling through architecture. We also believe that in the future the architect's network of advisors will expand to include experts from previously unrelated fields: no longer will only the structural engineer be essential within the profession, but the software engineer will also play an increasingly important role in the development of intelligent, communicative buildings.

5 ACKNOWLEDGMENTS

Thank you to our clients and consultants for sharing our visions and making it possible for us to turn possibilities into realities.
Image credits: © UNStudio

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Investigating Multi-User Interactions on Interactive Media Façades

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Figure 1. Examples of different media façades situated in public places with the potential of enabling multi-user interactions. On the left and in the middle light-emitting façade types, on the right a back-projection high-resolution façade type.

ABSTRACT
Designing interactions with media façades bears several challenges. One of them arises when multiple users are interacting with a media façade simultaneously. In this work we report on our experiences designing a mobile multi-user interaction system with a high-resolution back projection media façade in a public space (see Figure 1, middle). We compare different methods to distribute *temporary ownership* of a media façade. We further describe our systematic design process of prototyping such a system at different scales. Our presented work covers preliminary insights into the design process of media façade interactions and it addresses domain specific challenges such as designing multi-user interactions from scratch.

Categories and Subject Descriptors
H.5.2 Interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Design.

Keywords
Media façade, design process, multi-user.

MAB '14, November 19 - 22 2014, Aarhus, Denmark. Copyright is held by the owner/author(s). Publication rights licensed to ACM.
ACM 978-1-4503-3302-3/14/11…$15.00
http://dx.doi.org/10.1145/2682884.2682893

1. INTRODUCTION
The augmentation of urban spaces with digital technologies, commonly referred to as *media architecture* [9,16], increased over the last decade. Besides sensor networks, the huge amount of mobile devices carried in urban spaces, the manifold variety of situated public displays and video walls, media architecture has become ubiquitous [21,22,32,33]. One domain aspect in this field deals with the augmentation of buildings through interactive technologies, summarized under the umbrella term *media façade* (see Figure 1). Prominent examples in the recent years denoted turning the outer shell of a building into a gigantic urban screen [4,7,13, 28,35].

In contrast to situated public displays, *media façades* are of architectural scale and they therefore require a certain minimal viewing distance for being able to perceive the displayed content as a whole (compare Figure 1). Due to their size, they also have great visibility, resulting in a large number of potential users. This stands in contrast to situated public displays, where the maximum number of people that can gather in front of a display is naturally constrained by the available physical space [8,24].

In the past years, researchers, architects and practitioners investigated means for interacting with media façades [6,11]. However, when multiple users are interacting with a *media façade* [12], users might not necessarily see each other; instead they might be scattered across a large open space. In such cases we face one major previously identified issue [11] with interactive media façades: When interacting with a media façade as a *shared screen,* with multiple users in parallel, territorial issues can arise on the façade causing user frustration [24]: (1) when users are familiar with each other, they often interact collaboratively, in contrast, (2) when they are unaware of each other, they compete for access to the shared *media façade*, which can cause several issues due to the absence of any moderation mechanism, deciding who is interacting at what time and for how long [4,35].

Our conducted research investigates the suitability of different *means* to distribute *temporary ownership* over a media façade to increase the users experience when interacting with multiple users and at the same time. In our previous research we explored the systematic design process and the investigation of suitable evaluation methods to address the domain specific challenges of media façade operation in public settings. In this work we report on our experiences of:

- **Transferring** an extended user-centered design process approach to different façade types (i.e., high-resolution back-projection media façades).
- **Designing** and **preliminary evaluating** suitable turn-taking mechanisms for the distribution of temporary ownership. To do this we designed and implemented three mechanisms to share *temporary ownership* on a media façade with multiple users: (1) ***Time-Multiplexing***, where users periodically have *exclusive* access to the whole façade, (2) ***Space-Multiplexing***, where each user is assigned a *fixed part* of the façade, as well as (3) as a ***Mayor-Mode***, where users need to accomplish local tasks on their mobile devices to earn *exclusive access* to the façade until being *removed* by another user. In particular, we compare these three approaches with respect to their ability to minimize frustration and to increase enjoyment when distributing *temporary ownership* on a shared media façade.
- **Investigating** if prototyping evaluations involving multi-user media façade interactions can be seamlessly transferred from a small-scale setup (i.e., in a research lab) to a full-scale implementation on the actual scale in a public setting. We applied a two-step approach using small scale and full-scale prototypes to test our concepts for different levels of abstraction from the final setting. We discuss the implications of the evaluation for both the applicability of different scale prototypes when designing multi-user interaction with media façades, and the potential of the previously introduced turn taking methods to minimize frustration and increase enjoyment when multiple users interact with a shared media façade.

Our investigations include a description of a case study using an extended design process that others can follow when being confronted with interactive multi-user installations for media façades.

2. RELATED WORK

Urban Spaces are emerging prime locations for the deployment of digital technologies, such as media façades [13,27,30]. In general, *media façades* (see Figure 1) refer to the concept of turning the outer surface of a building into an architectural scale public screen by equipping it with digital, light emitting elements or projections of various kinds [16].

2.1 Categorization of Media Façades

As previously discussed the umbrella term *media façade* describes the idea of transforming the outer shell of a building into a gigantic urban screen [6]. As Haeusler exemplified, they vary in their size and resolution and they can be constructed using different technological means [16,33]. Light emitting façade types, for example, use light emitting diodes embedded in the façade of a building to create the opportunity of changing the façade into different colors (see Figure 1, right). Further, technological solutions include the augmentation through high-resolution projectors that display their content via semi translucent materials applied on the façade to reflect the content on the surface, summarized as *back-projection façades* [16] (see Figure 1, right). In former investigations we dealt with light-emitting façades. Hence, we could not judge the transferability of our design process (i.e., miniaturization of the façade to a small scale model) approach to other façade types, with different color models and technical capabilities [16] (i.e., front or back-projection media façades). In this work we observed the design process of prototyping miniature models of the interactive system before the final implementation in full scale, using a high-resolution back projection façade.

2.2 Interactivity and Media Façades

In the past years, researchers and practitioners started to explore the capabilities of media façades for various reasons, including experimental realizations of interactive installations. In general, media façades can be categorized as follows: (1) **Narrative media façades** remain in a static state and *communicate* ambient or high-resolution information to an audience that has to be encoded by the recipient. (2) **Reactive media façades** gather their content through the surrounding environment via, for example, a network of sensors that provide input data. (3) **Interactive media façades** provide a direct or indirect interaction mechanism that let users access and manipulate content. The latter type also served as the focus of our research investigation. Early examples of interactive façade types include the arcade game classic “Pong” which has been transferred to a media façade by the Chaos Computer Club (CCC) in Berlin, Germany [7]. While this type of interaction was performed via a mobile device and a dial up modem hooked up with a server other examples including interactivity were using screens in front of the building, commonly referred to as *kiosk interfaces*. Embodied interaction mechanisms in this realm can utilize computer vision to empower users to interact with content. While the investigation of interaction mechanisms was tackled in our previous work, we investigated how multiple users could interact with content simultaneously including a *moderation mechanism.* Because the social protocol influences this type of interaction [14], it plays a significant role in the users experience compared to interaction forms were individuals have their personal screens (i.e., mobile devices) as feedback channels: when media façades become an output channel for multiple entities interacting with the system, conflicts are bound to happen as individuals might interact with the provided content in different ways and at the same time [35].

2.3 Interaction Techniques

Turning media façades into interactive surfaces has been subject to a wide range of research. In [4], Böhmer et al. used basic games to create playful engagement with a media façade, utilizing mobile devices as input devices. Boring et al. introduced Touch Projector [5], an augmented reality (AR) approach allowing multiple-users to simultaneously interact with a distant digital screen shown in the screen of a mobile device and using touch input in real-time. While *Touch Projector* is dedicated to indoor display environments, Boring et al. further adapted *Touch Projector* to allow multiple users to simultaneously interact with a media façade, in an outdoor setting [6]. While allowing for simultaneous interaction with a shared canvas (e.g., the media façade), this approach does not provide means for turn taking or moderating the interaction. As exemplified by Wiethoff and Gehring, this can lead to frustration among the users [35]. With *MobisSpray*, Scheible et al. utilized a mobile device as a digital

spray can to allowed users to virtually *paint* graffiti onto a projected media façade [27]. Distributing temporary ownership over the façade was handled by passing the dedicated mobile device on which the MobiSpray application was running. Fischer et al. followed a similar approach of taking turns while allowing multiple users to simultaneously interact with a media façade [13]: With *SMSlingshot*, they presented an interactive installation allowing users to simultaneously *shoot* colored text messages onto a projected media façade by aiming at the façade with a wooden slingshot, a custom made input device [13]. The number of parallel users in this case was restricted by the number of available input devices, which forces the users to take turns by passing on the input device as well. In our work we explicitly focused on the interaction with a media façade using mobile devices [6]. Through this technology platform, we avoid the need for passing on a device to take turns and we utilize a commonly available and familiar input device. Simultaneous interaction of multiple users with a shared display is a well-known issue in the interactive tabletop community. Marshall et al. investigated how different configurations of input can influence equity of participation around a shared tabletop interface [20]. Users in groups of three had to work on a design task requiring negotiation on different interface conditions. They found that a shared multi-touch surface increases physical interaction equity and perceptions of dominance, but does not affect levels of verbal participation [20]. Shen et al. designed, implemented and evaluated different interfaces for shared tabletops, as well as interaction techniques and usage scenarios fostering simultaneous interaction of multiple users [31]. Scott et al. critically investigated collaboration around a shared tabletop displays [29]. They provided various guidelines for effective co-located collaboration, including that technology must support *natural* interpersonal interaction, as well as transitions between personal and group work. Greenberg et al. investigated how people move from individual to group work through the use of both personal digital assistants (PDAs) and a shared public display [15]. They highlighted a variety of problematic design issues that result from having different devices and having the system enforce a rigid distinction between personal and public information. Paek et al. also combined large, shared displays with mobile personal devices for simultaneous interaction of multiple users [23]. They built a platform to access content on the shared device with their personal mobile device while they demonstrated the platforms generality and utility in various group settings.

2.4 Regulating Participation

The main focus of our work lies on multi-user interaction with media façades: when multiple users interact with a shared surface, the users' interactions need regulation. Regulating conversations and interactions with groups of people had been subject to research in different fields. Sacks et al. investigated the organization of taking turns to talk in conversations [26]. They proposed a model for the turn-taking organization, which they examined for its compatibility with a list of grossly available facts about conversations. Their results suggest that a model for turn-taking in conversations is characterized as locally managed, party-administered, automatically controlled, and sensitive to recipient design. In a meeting scenario, Roman et al. presented a longitudinal study on the participation regulation effects on conversations in the presence of a speech awareness interactive table [25]. They showed that an effect of balancing participation develops over time and they reported other emerging group-specific features such as interaction patterns and signatures, leadership effects, and behavioral changes between meetings. Their work shows how introducing technology can regulate behavior in conversations. With *Reflect,* Bachour et al. provide an interactive table for regulating face-to-face conversation for collaborative learning [1]. They argue that in such a scenario, unbalanced participation often leads to the undesirable result of some participants experiencing lower learning outcomes than others. The *Reflect* table provides feedback to the participants on the level of their participation could have a positive effect on their ability to self-regulate, leading to a more balanced collaboration. Their evaluation of the system shows a positive effect of the table on the group regulation and the learning effect. Bergstrom et al. introduced the *Conversation Clock* for visualizing audio patterns in conversations of co-located groups [3]. They explored the nature of group interaction by augmenting aural conversation with a persistent visualization of audio input. The Conversation Clock displays individual contribution of a participant via audio input and provides a corresponding social mirror over the course of interaction.

The aforementioned research presents different approaches for regulation conversations with multiple, co-located participants. The characteristics of media façades in combination with the highly dynamic public setting they are situated in, raise additional needs. For example, media façades are very large in size and therefore visible – and interactive – from large distances. While users can simultaneously interact with a shared media façade locally, they are not necessarily co-located. In this paper we therefore investigated turn-taking strategies addressing such scenarios.

2.5 Challenges Designing Interactions

Due to their enormous size, resulting in a great visibility and the circumstance that media façades are situated in a highly dynamic context with rapidly changing conditions, new challenges arise for designers, architects, researchers and practitioners when designing interactions. Dalsgaard and Halskov summarized eight key-challenges [11] as a reference. One of them stresses that the developed content itself has to suit the medium: the installation has to address the diversity of situations in public spaces, such as a high and rapid fluctuation of users and multiple users in parallel. Furthermore, introducing public interfaces and allowing multiple-users to interact in parallel with a shared public screen can also transform social relations and cause disruptions in social protocols [12,14].

In addition to that, media façades limit prototyping on a large-scale: most of the previously described media façade types are not visible and active during daylight, which restricts the times suitable for pre-testing to only a few hours. Another aspect that makes pre-tests difficult is that the outcome of early experiments is already visible to a large audience, as media façades are mostly situated in prime urban locations, with many passerby. For these reasons, not many design iterations are feasible on the façade itself. This leaves designers and developers with pre-testing both novel interaction and/or content on smaller scales with different characteristics before deploying the resulting system on the target façade [35]. These matters justifies a miniaturized prototyping approach before going full scale [34]. Furthermore, there is very few reference literature available for this context. The same applies to the question if user data gathered on a small scale (i.e., in a lab setting) can be seemliness transferred to a full scale setting and result in similar findings. To address this shortcoming we compared similar setups in our work that would only differ in one parameter: scale.

3. INVESTIGATING MULTI-USER INTERACTIONS

3.1 Small Scale Lab Study

To follow the extended design process approach [35], a first experiment was conducted using a prototype in a lab setting (see Figure 2). Therefore, we created a true to scale 1:100 miniature model of the media façade in question of accordance to [34]. The miniature model was equipped with an A+K *AstroBeam* X20 projector to back-project content onto the miniature media façade, simulating the façade while correctly mapping the hardware interplay between client device and media façade. To put the prototype into context, it was situated on an interactive tabletop showing *Google Earth* images of the façade's *real* deployment location (i.e., a large European city) in a public place, correctly aligned around the mockup. The same computer controlled the content displayed on both the miniature media façade and the tabletop. During the study, the participants used a *HTC One S*[1], a *Samsung Galaxy S2*[2] and a *Samsung Galaxy S3*[3] mobile device as a local client (see Figure 2).

Figure 2. The participants interacting simultaneously with a small-scale prototype of the media façade in a lab setting.

Similar to the setup of the actual media façade, all components of the small-scale setup in this study were connected via a local *WiFi* network.

3.1.1 Tasks

As the overall task of study the participants had to solve a *tile puzzle* (see Figures 3&4) on the media façade with a mobile device as input. The application consisted of a tiled image with shuffled tiles in a randomized order. By moving an *empty* tile via touch input on the mobile device, the participants had to reorder the tiles to reconstruct the original image in order to complete the task. The task was chosen to (a) empower a short-term playful engagement with the media façade which could be played with multiple users simultaneously and (b) using mobile devices a access medium. A previously conducted field study revealed that the majority of the passerby in front of a public media façade appreciated the opportunity of being involved in a local game which would be performed on the façade [35].

Figure 3. Left: The user interface of the tile game played in the study. Right: The local qualification game (*Rock, Paper, Scissor*) played in the *Mayor Mode* to qualify for exclusive access to the façade.

Each participant had to solve the task in three different conditions: (1) *Time-Multiplexing*, (2) *Space-Multiplexing* and (3) the *Mayor-Mode* which were assigned to the participants via a 3x3 Latin Square.

Time-Multiplexing: The *exclusive* ownership of the façade was changing between the participants similar to a *token ring*. The participants sequentially had *exclusive* access to the façade for 30 seconds in each turn, where only the *temporary owner* (i.e., the person interacting with content displayed on the media façade) was able to interact while the remaining participants had to wait for their turn. In this mode, one tile game had to be solved collaboratively on the façade by taking turns.

Space-Multiplexing: In this mode we subdivided the media façade into three separate segments. Similar to the common split-screen pattern, each participant was the *exclusive owner* of one part. The tile game was therefore split into three regions on the façade, each assigned to one of the participants. To solve the tile game, each participant had to solve their own part. While this mode allowed each user to permanently interact with the façade, it also constrained the available façade space per user.

Mayor-Mode: In this mode, we introduced a local qualification game, inspired by a social media platform[4], played only on the personal mobile devices, as a competitive factor: the participants had to win a game – a clone of the *Rock, Paper, Scissors* game tied to a social protocol in phases of decision making to *earn* exclusive ownership on the façade and become the *mayor* until being replaced by another participant who had won the local game and earned more points (see Figure 3, right). By performing well when gaining access and playing the previously introduced *tile puzzle game* on the façade, participants were being able to extend their *mayorship*. In this mode, again one tile game had to be solved on the façade by one participant being able to interact with the media façade individually.

Since all possible interactions consisted of moving the blank tile to one of its neighbors' position (top, bottom, left or right), we designed the tile game that the participants had to use simple swipe gestures on the mobile device's screen implying the direction taking the location of the blank tile as a reference (compare Figure 4). Hence, by using the mobile device as a pure input device and by displaying the visual content of the tile game only on the façade, we lowered attention shifts and engaged the participants to focus on the façade while interacting and not on the mobile device (compare Figure 3, left).

3.1.2 Participants, Data and Analysis

For the small-scale lab study, we recruited a total of 15 participants (6 female) with an average age of 25.4 years. They rated their own technical experience with: novice (two), minor

[1] http://www.htc.com/de/smartphones/htc-one-s/
[2] http://www.samsung.com/de/consumer/mobile-device/mobilephones/smartphones/GT-I9105UANDBT
[3] http://www.samsung.com/us/mobile/cell-phones/SCH-R530MBBCRI

[4] https://foursquare.com/

experienced (two), average experienced (two), rather experienced (four) and very experienced (five), on a five-point *Likert-scale* ranging from 1, meaning "no experience" to 5 meaning "very experienced".

The participants were divided into groups of three and we paid careful attention that participants did not knew each other before the experiment due to the aforementioned challenges. Each group received an initial five minutes introduction to the context, the application, and the three turn-taking methods previously described. After the introduction, each group had to solve the described task in all three conditions (Time-, Space-Multiplexing and Mayor-Mode), assigned via a 3x3 Latin Square. After completing all tasks, the groups were asked to fill out a questionnaire. The questionnaire consisted of three parts, covering (a) usability aspects and (b) user experience (UX) measures as described by [2,18,36]: The first part of the questionnaire was addressing the general usability of the prototype using open questions. The second part of the questionnaire investigated the perceived user experience while solving the tasks, as well as a subjective rating of the three applied turn-taking methods. The participants were asked to answer questions on a 5 points *Likert-scale*, ranging from 1, meaning "strongly disagree" to 5, meaning "strongly agree". The last part included a *SAM Scale* [2] focusing on the overall experience in retrospective. The latter served as subjective means to investigate the perceived individual user experiences (UX) [18]. Additionally, we videotaped each group where we focused on both the participants' behavior within the group as well as the interactions with the prototype.

We analyzed both the qualitative data on the general usability and the user experience collected through the questionnaire, as well as the recorded video footage via open coding [10,19], next we clustered the individual data pointers into main categories using *Affinity Diagramming* [17]. The UX part of the questionnaire focused on positive and negative emotions considering the overall interaction experience. In particular, we focused on what was assumed to be *strengths and limitations* of the three turn-taking modes, which were considering the social peer-pressure during the interaction, loss of façade access, inactivity, collaboration and motivation. In the following we exemplify positive (+) and negative (-) statements.

3.1.3 Results

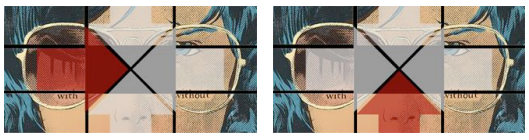

Figure 4. Left: Moving the left tile of the middle row to the location of the blank tile by performing a swipe gesture from the tile towards the blank tile. Right: Moving the center tile of the bottom row accordingly.

Regarding their preferred turn-taking mode the participants voted the Space-Multiplexing followed by the Time-Multiplexing and the Mayor-Mode with similar scores. A broad set of reasons was given to explain the rating. While the Mayor-Mode was considered as "*very competitive"*, the Space-Multiplexing mode was perceived as a *"good compromise"* in contrast to the other turn-taking methods. One pattern in the data indicated that participants appreciated that *"no interruptions occurred during the game"* in contrast to the other mechanisms and that participants *"definitely got to play"*.

The data pointers collected via the video recordings for the **Time-Multiplexing** mode were matching the researcher denoted concepts [10] "pleasure stimulation" and "enjoyment" (ten positive statements), on the other hand the interaction also led to "frustration" and "irritation" (four negative statements). Reference Quote (+): "*Fun, simple and teamwork*." Reference Quote (-): "*If you don't pay attention and miss the start of your turn, you loose playtime before you have to wait again. That's frustrating!*" While the Time-Multiplexing mode was perceived to have a *"cooperative character"* as idle players often tried to help active players while they had to wait for their turn, *"boredom"* was stated as a main reason for this. Further, the *balance* between activity and inactivity was causing *"frustration"* since three users played the game and each user had to wait twice as long as they were able to play per turn.

Using **Space-Multiplexing** users enjoyed having permanent access to one part of the façade, the competitive aspects solving one part of an overall task were creating both, *enjoyment* (three positive statements), and *frustration* (eight negative statements). Reference quote taken form the video footage (+): "*Classic competition!*" Reference quote (-): "*I felt rushed to complete my puzzle.*" Overall, this mode was being perceived as a *"good compromise"* compared to the other settings because participants traded *screen space* for continuous access to *their* part of the façade. However, for the described setup, the participants stated that due to the small size of the prototype, they emphasized to *"play the space multiplexing mode on a bigger screen*".

The **Mayor-Mode** created the most diverse spectrum of statements (6 positive and 27 negative quotes) among the participants in contrast to the other turn-taking mechanisms. Concerning the previously described meta concept of *"frustration and irritation"* in this mode, the fact that the participants had to compete **before** becoming the *mayor* and getting *exclusive access* to the façade and that they did not automatically get access at some point was stated as one of the main causes of *"frustration"* especially by the technically very inexperienced participants. Positive reference quote from the video footage (+): "*I really liked that I can earn more play time by performing well.*" Negative reference quote (-): "*I often lost in the qualification game. That gave me a hard time to play on the façade at all!*".

Asked about the most enjoyable mode in direct comparison of the three applied modes, the participants chose the **Space-Multiplexing** mode to be their favorite approach:

1. Space-Multiplexing (48.8%)
2. Time-Multiplexing (25.6%)
3. Mayor-Mode (25.6%)

Asked about the reason for their vote, the participants stated space multiplexing to be the most enjoyable compromise because they *"got at least enough time to play"* (the game).

3.2 Full Scale Study

3.2.1 General Technical Setup

The large-scale setup in the final condition was conducted at a media façade in a public space measuring 32 square meters (see Figure 5). The back-projection media façade embedded in this building utilized a total of five HD projectors that were aligned via a VGA signal splitter and custom software. The projection was visualized via an expandable curtain consisting of rear

projection capable material that covered the large glass front on the first floor. A local *WiFi* network allowed simultaneous access for the provided smartphones. A Teamviewer[5] connection on a

Figure 5. The for the full scale study utilized media façade situated in a public place within the heart of a mid-size European city.

remote local laptop served as medium for monitoring the experiment constantly without leaving the space in front of the façade area where the participants were interacting. Two Samsung Galaxy S3 and one Samsung Galaxy S2 smartphones again served as local access devices for the participants to work with the provided content. The content and the interaction mechanisms were similar to the previously described small scale experiments.

3.2.2 Participants, Data and Analysis

For this setup we recruited a total of 16 participants with an average age of 28.9 years. In a self assessment consent form the participants rated their own technical experience with: novice (one), minor experienced (two), average experienced (five), experienced (five) and expert (three), on five-point *Likert-scales* ranging from 1 meaning "no experience" to 5 meaning "expert".

The study was conducted as follows: first the participants received a five minute introduction to the context, the application and the different turn-taking modes. After that the participants had to solve the task using the different turn-taking modes. After three rounds the participants were asked to a separate room where they had to fill out a questionnaire. The questionnaire was designed combining three investigation methods and focused on different parts of the perceived interaction experience and was similar to the previously presented study setup. This was done to investigate if the results of both (small- and full scale) study settings were indicating similar data cues and as a way to judge the transferability of both settings. The whole setup was again recorded via two video cameras focusing on (a) the participants actions, (b) quotes and (c) the overall interaction experience with the façade. Additional photographs were taken.

The recorded video material was analyzed via open coding [10] and emerging patterns summarized under the previously described positive and negative meta categories.

5 http://www.teamviewer.com

3.2.3 Tasks

The participants had to solve the same task as previously described setups. Assignment of the tasks and randomization via a 3x3 Latin Square were also similar.

3.2.4 Results

Despite the positive motivational aspects of the Mayor-Mode, (see Figure 6). The overall assessment of rating the different mechanisms with another in direct comparison indicated different tendencies: The Space-Multiplexing mode received the highest percentage of positive votes followed by Time-Multiplexing mode. The Major-mode was ranked last.

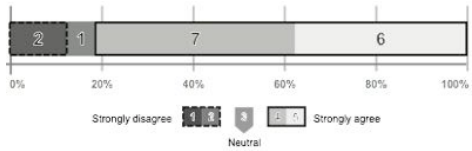

Figure 6. Response frequencies to the *Likert-scale* question: "I felt motivated to become the "mayor" and gain access to the media façade in full screen."

Regarding the perceived interaction experience in contrast to other participants interacting simultaneously on the media façade using the Space-Multiplexing mode, the majority of the users (15) did not find it disturbing that others were using the access to the façade via their mobile device (see Figure 7) at the same time.

Meta-concepts emerged after a first iteration of interpreting the video footage which focused on positive and negative emotions considering to overall interaction experience: "pleasure stimulation" and "user satisfaction" as positive emotions (+) vs. "frustration" and "irritation" for negative emotions (-).

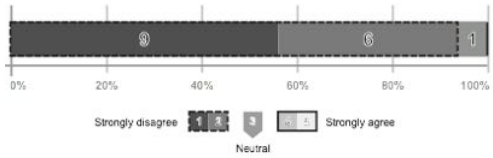

Figure 7. Response frequencies to the *Likert-scale* question: "I found it disturbing that other users were interacting with different regions of the screen."

In total, three positive data pointers were sorted for **Time-Multiplexing** matching the main concept "pleasure stimulation and user satisfaction" as well as three negative data pointers for "frustration and irritation". Reference quote from the video footage (+): *"We were able to communicate with each other during the breaks"*. Negative reference quote when using the **Time-Multiplexing** mode (-): *"I was interrupted in the middle of my thoughts which felt disturbing"*.

The **Space-Multiplexing** mode received also three positive data pointers for the concept "pleasure stimulation". On the contrary it caused more "frustration" among the users as a total of five negative data pointers indicated. Positive reference quote from the video footage (+): *"This mode is an appropriate mix of competition and cooperation."* Negative reference quote (-):

"Because of me, the others have to wait now (until I am finished solving the task)".

The **Major-Mode** was again causing a very diverse spectrum of experiences by the participants. On one hand eight positive quotes were sorted under the concepts "pleasure stimulation" and "user satisfaction". This was influenced by the circumstance that technological experienced users had a higher probability of gaining long term ownership over the façade. On the contrary 17 negative quotes were sorted under the meta-concept of "frustration" and "irritation" caused by users who had difficulties gaining enough points to get access to the façade. Positive reference quote from the video footage (+): *"I liked the competition in this mode which forced me to play fast to keep my status"*. Negative reference quote (-): *"I felt excluded form the group and in the task operation on the media façade while solving the qualifying game"*.

3.3 Summary

Considering both setups in retrospective we acknowledge that all of the investigated interaction mechanisms had their advantages and disadvantages (see Figure 8).

While the Time-Multiplexing mode was being perceived positively as users stated that is was *"self-explanatory", "fostering communication and collaboration"* among the participants it also caused frustration irritation as it was causing *"inactivity"* and *"boredom"*.

	Time Multiplexing	Space Multiplexing	Mayor Mode
Pro	Fostering Collaboration, Self-explanatory	Continuous Interactions, Simultaneous Tasks	Playful Competition, Rich Interaction Experience
Con	Inactivity	Isolation	Technical Skills Affect Interaction Experiences

Figure 8. Summary of the pros and cons of the different turn-taking modes in direct comparison.

The Space-Multiplexing mode was being perceived positively as it was *"self-explanatory", "provided clear constraints and borders"* and led to *"more tasks that could be performed on the media façade at the same time"*. On the contrary it also led to *"isolation"* among the participants and causing peer-pressure on the users to *"perform the given tasks fast"*.

The Mayor-Mode provoked the most diverse feedback in term of positive and negative statements. On the positive side participants stated it advantageous that *"no interruption occurred during the game"* as in case of the time-multiplexing mode. It led to positive experiences by the users who gained exclusive access to the media façade though the qualifying mechanism. On the other hand more user prompting was required compared to Time- and Space-Multiplexing mode due to its *novelty*. It further also caused "frustration" among technical inexperienced users who were outperformed in the qualification game and did not manage to gain access to the façade at all.

A direct voting collected throughout both setups identified the Space-Multiplexing as the *"most pleasant"* to use in direct comparison with the other mechanisms:

Space-Multiplexing (47.2% of positive votes)

Time-Multiplexing (30.2% of positive votes)

Mayor-Mode (23.3% of positive votes)

In both settings we observed that the feedback from the users collected through the questionnaires showed similar tendencies. However, in the small-scale lab setting the spatial configuration caused limitations in the sense of a shared space [10] in front of the media façade due to the miniaturization. Hence, in a future setup it would be advantageous to overcome this issue by providing multiple instantiations of the prototype to allow a *more fluid* positioning of the users in front of shared façades.

4. DISCUSSION

In our work we provided preliminary insights from using different turn-taking mechanisms in conjunction with interactive media façade interactions. Since media façade interaction is influenced by both, the properties of the façade itself in combination with the appearance of the content, as well as the spatial arrangement of the space in front of the façade from where people interact, we tested different turn-taking modes with prototypes on different scales. By using a small-scale prototype, we have noticed that the spatial setting in front of the façade cannot be modeled sufficiently. In general, the data collected in the both setups showed similar tendencies in both perceived usability satisfaction and the general user satisfaction with the different turn-taking modes. Hence, we acknowledge that using miniature prototypes to investigate interfaces for media façade interaction can provide valuable insights on the usability and the perceived user experience of the target setting. While the small-scale lab setup was focusing on the façade itself, the full scale setup was additionally focusing on the spatial setting around the façade and produced similar results (e.g., the participants' answers showed the same preferences). This could also be seen as a limitation of our approach: Since we utilized a miniature model of the final façade for the small scale prototype, we could correctly map the façade and the displayed application, but not the spatial setting in front of the façade. Hence, using the small-scale prototype, we could not investigate how people spatially distribute themselves within the potential interaction space in front of the façade and how they interact with each other or with the media façade when being spatially separated.

In summary we provide preliminary insights into the design process of interactive media façades in multi-user environments while investigating an extended design process for media façade interaction, involving a high-resolution back-projection media façade. To gather insights into the design, we conducted both a user evaluation *in the wild* and user evaluations in controlled settings with prototypes on different scales. We collected and compared the data sets gathered in both studies and compared them to find commonalities and differences of their applicability in particular stages. The collected data indicates that prototypes on different scales are generally applicable during the design, providing initial feedback on usability and user experience in this context. However, we have noticed that small-scale models are less suited when focusing on the behavior of users within the interactive space in front of a media façade.

5. CONCLUSION AND FUTURE WORK

The domain of interactions between people and buildings through interactive media façades is a novel yet emerging research context. However, systematic design process models or guidance literature on how to envision, prototype, pre-test and implement

multi-user systems from scratch is missing. This becomes an even more complex task if domain specific challenges arise when interacting with media façades [11]. These circumstances demand special considerations to the human factors by the people who design and pre-test these systems. To preliminary investigate some of these challenges we have presented a case study, which describes (a) an extended design process for media façade interaction on different scales and (b) investigated the distribution of *temporary ownership* when multiple users are interacting with such a system in parallel through different moderation mechanisms.

In a following project we will focus on an deeper investigation on the social and spatial factors of the previously addressed challenges to create systematic prototyping tools designers and architects can use and make the interaction between people and media architecture usable and enjoyable.

6. ACKNOWLEDGMENTS

We would like to thank the University of Fine Arts Saar (HBK) for granting us access to their media façade.

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Critical Perspectives On Media Architecture: Is It Still Possible To Design Projects Without Negatively Affecting Urban Nighttime Environments And Will The Future Remain Dynamic, Bright And Multi-Colored?

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ABSTRACT
Nowadays, due to advances in electrical devices, new digital media, lighting, information and communication technologies, cities are being used 24/7. The paper discusses critical aspects of Media Architecture in the context of public spaces as well as urban nighttime environments from the perspective of a practising lighting architect. The author examines recent issues of negative design approaches and presents proposals for improving future projects in the form of guiding principles. Additionally, to better illustrate the phenomenon, an attempt has been made to standardize terminology and to clarify the topic of Media Architecture in the context of artificial light used in the urban environment based on the author's practical and theoretical research work in the field.

Categories and Subject Descriptors
J.5 Arts and humanities: Architecture

General Terms
Design, Theory.

Keywords
Media Architecture, Environment, Exterior illumination, Urban lighting, Urban nighttime environment, Light pollution, Darkness, Lighting masterplan, Digital layer, LED, Media façade, LED display technology.

1. INTRODUCTION
The experiences of creating all kinds of illuminated advertisements played a significant role in the development of modern concepts of illumination of buildings, including Media Architecture. Already in the late nineteenth century New York's street frontages were overloaded with a decorative collage of words and images[1]. Most of them, however, were not visible after dark, until the advent of the first commercial electric advertisement on Broadway - a big sign welcoming people to the resort of Coney Island. A multicolored text made up of plain letters filled the greater part of the wall of the building. Newly invented electric flashers blinked six different lines of text composed of electric light bulbs in sequence. People were captivated by the format of this ad and surprised by the fact that they could see it from such a long distance[2]. The sign became a sightseeing attraction for both locals and tourists. For the first time media was "communicating" its message to the public in the physical surroundings of the streets and buildings of New York City. Within a few years, Broadway and Times Square were transformed into the most important American market of outdoor advertising[3]. Soon, to attract the attention of wealthy, well-educated passersby, traders were spending thousands of dollars to illuminate the name of their company[4]. Streets turned into centers focusing not only on trade and commerce, but also became a kind of cultural hub - theaters, concert halls and luxury hotels were adjacent to each other[5].

Time Square also became something of an ancient agora, a place of assembly, where news was awaited in the form of illuminated newspapers which reported on the results of the presidential election, baseball matches and the inauguration of the next New Year. Over the years, illuminated electric signs gave the town a unique visual identity and a new form of existence - exclusive nightlife. The street became an exciting place just after dark, a magical show of color and light. Advertising for Broadway shows "grew" over all facades and rooftops around the square[6]. Even on Sunday evenings, when the theaters were already closed, crowds walked up and down Broadway to look at the latest dazzling light shows that so strikingly resembled the cinema. These animated signs evoked a similar type of visual wonder and exaltation as the fireworks shows during the first World Fairs.

While travelling to New York in 1924, Erich Mendelsohn, one of the leading German architects of the modernist era, described his experiences and fascination with the lighting spectacle in Manhattan:

MAB '14, November 19 - 22 2014, Aarhus, Denmark. Copyright is held by the owner/author(s). Publication rights licensed to ACM.
ACM 978-1-4503-3302-3/14/11…$15.00
http://dx.doi.org/10.1145/2682884.2682893

"Uncanny. The contours of the building are erased. But in one's consciousness they still rise, chase one another, trample one another. This is the foil for the flaming scripts, the rocket fire of moving illuminating ads, emerging and submerging, disappearing and breaking out again over the thousands of autos and the maelstrom of pleasure-seeking people. Still disordered, because exaggerated, but, all the same, full of imaginative beauty, which will one day be complete"[7].

When electric bulbs, controlling devices and electric circuits developed with time (like LED light sources and illuminated "pixels" today) the production cost of electric signs became cheaper. This permitted architects and designers to create bigger and more complicated advertising signs with gradually more complex moving forms put onto the building façade.

To put it colloquially, today, "painting with light" requires highly specialized knowledge of many still developing disciplines. Considering light architecture as akin to media architecture, the standards that were once widely accepted and used are no longer allowed. An example would be the great illuminations New York skyscrapers implemented in the twenties and thirties of the twentieth century, which are completely unacceptable today. Then, a "shooting up" illumination amazed people and was something the designer could be proud of. Today, however, it would probably even cause embarrassment because the projects would be considered non-ecological, leading to excessive light pollution, and, in addition, consuming a lot of electricity.

Nowadays, a similar situation is being repeated. Many contemporary creators of Media Architecture (architects, artists, designers, interactive technology specialists etc.) do not consider at all the consequences that their actions may bring in the future. That is why it is so important at the beginning of this new, emerging field of design to start to pose the right questions about what its future and direction of development will be? Which criteria should be subordinated to the correct design solutions? Should there be an official body that would become the guardian of quality of created and delivered solutions for Media Architecture? This paper hopes to raise specific questions and find answers to challenges as well as present forthcoming possibilities.

2. DEFINITIONS

Most of the definitions associated with use of artificial light in urban environments and cited in literature, including Media Architecture, do not always reflect the full meaning of the terms used as this is such a new design discipline. There is a lack of established theoretical background research work, hence the effort to standardize terminology and to clarify the topic to better illustrate the phenomenon. The presented definitions are the author's proposals based on over 10 years of practical and theoretical research work in the field[8].

Exterior Illumination - deliberate use of artificial light originating or acting from outside in both the built and natural environment to achieve functional requirements and/or aesthetic effect.

Urban environment lighting - group of the outdoor urban elements (boundaries, gateways, nodes and places, districts, pedestrian and vehicular routes, buildings, structures, landmarks, soft and hard landscape elements, way finding, advertising, media architecture, light art as well as event lighting) illuminated by the means of artificial light at night These elements are part of the "mental map" which makes the nighttime environment recognizable and easy to navigate. Illumination helps to make the space/site understandable after dark and give it a unique identity. In order to define a comprehensive vision of exterior illumination for future developments of the whole or selected parts of the city an urban lighting masterplan should be put in place. Typically, this has the form of a document supported by graphics, tables and charts which serves as a guide for lighting designers, engineers, electricians, architects and other project team members. It provides detailed analysis of existing lighting conditions along with suggestions for improvement and proposals for saving energy. It also defines problems related to sustainability, ecology and environmental protection. It sets standards and criteria for implementing lighting, and organizes and creates a hierarchy of design priorities.
Project examples:
Lighting Masterplan for Trafalgar Square, London/UK[9], author: Speirs + Major;
Lighting Masterplan for Gardens by the Bay, Singapore/SGP[10], author: Kaoru Mende + Lighting Planners Associates;

Light Architecture (STATIC) - field within Exterior Illumination which officially began at the end of the 1960s with the establishment of International Association of Lighting Designers (IALD). Generally concerned with the permanent artistic illumination of new and historic buildings and structures emphasizing their aesthetic qualities via the projection of a light beam from a luminaire onto the surface. This is in contrast to the temporary use of lighting during events. Artificial light, being a technically difficult medium, requires mastery of diverse and constantly evolving disciplines. Similarly to architecture of buildings, it combines art and science and includes additional practical knowledge from disciplines such technology, ecology and business, going far beyond the aspects of visibility and horizontal illumination levels that were previously the domain of electrical engineers. Light Architecture is created both by lighting architects and architectural lighting designers.
Project examples:
The Louvre Pyramid, Paris/F[11], author: Claude R. Engle;
Erasmus Bridge, Rotterdam/NL[12], author: Lighting Design Partnership (LDP);

Media Architecture (DYNAMIC) - a new emerging field within Exterior Illumination, where dynamic graphics, text, image and spatial movement are displayed on elements of the built environment, usually architectural structures and buildings within public spaces. It has the capacity for adaptation and interaction with users by the application of modern digital technologies. The main function of media architecture is to "communicate specific information" in an active, dynamic and interactive form. Media façades and digital outdoor media screens emitting light are a vital component of media architecture and the digitalization of cities, forming part of original and intellectual enrichments of the urban environment with cultural, social and economic implications for the immediate surroundings. It is usually of permanent nature, but can have variable, temporary content.

Project examples:
The Chanel Ginza Tower, Tokyo/J[13],
author: Matthew Tanteri + Assocs., New York;
Kunsthaus Graz BIX Façade, Graz/A[14],
author: realities:united;

Light Art (STATIC / DYNAMIC) - a form of visual art where the main media of expression is an artificial light installation

inside the building, outside on its facade, or as an intervention in the landscape. The contemporary idea of light art developed with the progress of artificial light sources and experiments carried out by modern artists. This art form flourished in the 1960s and the work of artists such as Dan Flavin, Bruce Nauman and James Turrell, who formed light sculptures using linear fluorescent or neon lamps, were noticed internationally. Today, many artists use light as a medium in their artwork. Olafur Eliasson, Yann Kersale, James Turrell, Jenny Holzer and Keith Sonnier are just some examples. Light art can be used as content for media façades and Media Architecture.
Project examples:
Twilight Epiphany Skyspace at Rice University, Houston, Texas/US [15], author: James Turrell;
Nuit des docks, Saint-Nazaire/F[16], author: Yann Kersale;

Event lighting (DYNAMIC) - the purpose of lighting for temporary events varies from those of urban and architecture. Here the aim is that the performance will ideally leave a strong and long-lasting visual impression. There are various events that use lighting to enhance the emotional impact on the viewers:

• World Fairs - since their early beginning at the end of the XIX century, light shows and illumination of architecture have been a part of international exhibitions. These international events are typically held every few years, in varying parts of the world, and last a few months. The first World Fairs displayed technical inventions and advancements, including Edison's early light bulb. Later, their focus changed and they now cover everything from cultural exchange to national branding.
Project examples:
Panama-Pacific International Exposition San Francisco 1915[17],

• Son et lumière/Sound & Light Shows - is a form of nighttime entertainment that is typically presented in an open-air location of historic importance, where special projections onto the façade of a building, structure or ruin, a laser show and fireworks are synchronized with recorded or live narration and music to emphasize the history of the place.
Project examples:
Space of Freedom 2005, at the Gdańsk Shipyard/PL[18],
author: Jean Michel Jarre

• Urban Light Festivals - usually organized as annual event, often based on religious tradition. Many cities use seasonal darkness as an opportunity to celebrate light by holding festivals that last a few days and exhibiting beautiful temporary lighting installations. This includes illumination of buildings, light art and projections, recently as 3D mapping throughout the urban center allowing visitors and inhabitants to walk through the cities at night and experience them after dark in a completely new way.
Project examples:
The Fete des Lumieres (Festival of Lights), Lyon/F[19],
author: City of Lyon & annually invited artists;

• Open-air Music Concerts - considered to be large-scale concerts, featuring one band or different musical performers, sometimes including orchestras. They typically last from one to two or more days and attract very large crowds. With the development of new lighting technologies, employing stage lighting designers to "compose" an extraordinary, memorable music and light show on the stage became a must.

Project examples:
The Rolling Stones - Hyde Park/US[20],
author: Patrick Woodroffe;

• Openings and Closing of Olympic Ceremonies - through a well-choreographed visual show with music, dance, an artificial light show, fireworks, performances and digital projections, the opening and closing ceremonies invite the spectators to learn about the culture of the country in which the Games are taking place.

Project examples:
Opening and closing ceremonies for the London 2012 Olympic GamesLondon/UK[21],
author: Patrick Woodroffe;

3. CRITICAL ASPECTS OF MEDIA ARCHITECTURE

The following critical aspects of Media Architecture have been identified in order to highlight recent issues of negative design approaches and present proposals for improving future projects:

3.1 Lack of regulations and guidelines concerning brightness, motion and use of colour in the media architecture elements in urban spaces.

Throughout history a public space has been a flexible area open to diverse uses for communities to gather for historical, religious, social and cultural occasions or events. As soon as designers creating Media Architecture were given the new wonder of LED technology, which allowed them great flexibility and freedom in the use of this innovative medium, we found our cities awash with digital movement and colour in a way that creates a visual cacophony after dark and brings to mind a scene reminds sequence from a futuristic film. The affordability of technology has led to a new nocturnal experience of the XXI century city with a transformed urban nightscape with enormous media presence, often independent of the architecture and function of the urban area.

Due to the fact that this is such a new creative field and the complexity of the issue and the number of factors involved, there are, as yet, no regulations concerning motion and use of colour in media architecture in Europe. The problem of brightness has been addressed by the international community and currently all 28 member countries of the European Union should apply standard: "EN 12464-2 Light and lighting. Lighting of work places. Outdoor work places". Unfortunately, however, this document provides guidance rather than specific solutions, which means that the designer has total freedom to explore new techniques and use innovative equipment. This standard includes important recommendations on how obtrusive light can be limited in order to keep our night sky free of light pollution and includes a definition of Environmental zones. In addition, recommendations for good lighting practice to meet the needs for visual comfort and performance and all usual visual tasks are considered. Sadly, in practice, assessment of exterior lighting installations based on the environmental zones and the enforcement of standards in design practice when evaluating intrusion of light and approving lighting installations rarely takes place.

3.2 Impact on urban settings - nocturnal experience of a city

There is a long tradition of debate on the aspects of legibility in the urban settings. This change in the way of understanding the city which was initiated in the sixties turned out to be the key to today's concepts of lighting masterplans. As cities are highly complex urban organisms which are divided into districts (highlighted areas in the city due to the morphological structure or way of use). This reinforces the need to apply a strategy that will enhance the legibility not only by day but also after darkness. Well-designed and intelligently applied illumination has tremendous visual power. It can assist in revitalising urban environments[22] by signaling animation and activity and by enhancing existing perceptions of locations or buildings. At night, artificial light can make a city safer and more secure. But it also has an important aesthetic function. Often, as the starting point for contemporary projects of nighttime illumination of the city, Kevin Lynch's work is used[23]. According to his theory, when creating guidelines for nighttime illumination, elements which order the space, such as edges, paths, nodes, landmarks and districts, should be taken into account in a lighting masterplan. Lighting designers complement his approach with some additional elements like gateways, routes, landscape, location of a building in the urban and historical context, existing lighting and use of space/patterns of activity. Nighttime illumination of all these elements, which can be seen as connected "layers of light", influences the perception of urban space as well as the atmosphere and quality of life in the modern metropolis. They are part of the "mental map" (a generalized mental picture of the external physical world) which makes the environment familiar and easy to navigate. Therefore illumination should clearly articulate their form and highlight their visual identity.

Although the nocturnal landscape of the city is based on the composition of lit urban forms, the essence of a well-designed lighting masterplan is its continuity. The designer of single building illumination must, therefore, move away from thinking in terms of an isolated object. According to Lynch:"Nothing is experienced by itself, but always in relation to its surroundings" [24].

Selectively and sensitively illuminated buildings and the vistas to and from them can be enlivened and celebrated for their design and layout. But without a proper strategy in the form of a lighting masterplan this power can never be sufficiently controlled. An example being downtown area of the city of Baku/Azerbaijan, were there is complete lack of visual hierarchy as every façade of a building is illuminated in the similar manner with the same colour temperature and brightness[25]. Until these guidelines are formulated, the imbalance between the various elements of the nightscape will continue.

3.2.1 Lack of visual hierarchy of buildings in urban nightscape – legibility and image of city

Inhabitants and visitors are often much more comfortable in cities during the day than at night. Fortunately, well-designed exterior illumination after dark permits them to find their way around by identifying familiar landmarks and makes it possible for them to recognize the scale and dimension of the space they are navigating. It also supports the clear recognition of other people around them. As the technology for Media Architecture is widely available and so much more affordable than 10 years ago, there is a a risk that every new development will have more than one media façade to attract potential customers. After dark, when there is visual clutter and no hierarchy of buildings in the urban nightscape, many of these clues vanish and recognition can become reduced, leaving people feeling confused and lost.

Appropriate illumination of vertical planes on building façades is especially important for pedestrians, as they occupy a large percentage of their field of vision and, at the same time, allow recognition of a space[26]. Therefore, the nocturnal appearance of an area and its character is determined by the buildings located in it.

The main tool for creating visual hierarchy of buildings in the urban nightscape is lighting contrast. It highlights the key areas of presented architectural compositions after dark and is an essential tool for revealing form. Skilful dosage of contrasts allows the relative importance of individual components of the composition to be identified and determines the illusion of their distance from the observer. In exterior illumination this is defined by the intensity of artificial light, creating the impression of bright and dark surfaces. It is the surface brightness of a building as compared with unlit or at lower brightness areas at night which is a fundamental problem in nighttime perception. Too much light applied on buildings at night can significantly obstruct visual perception as well. Lower light levels are more likely to show the architecture, provided that the appropriate brightness ratio is established. While the first lighting designers used contrast in an intuitive way, studies today identify possible obtainable results quite precisely. The following Table 1 indicates the values of Luminance Contrast Ratio, which defines brightness of the object to the brightness of the background in such a way as to achieve a specific visual effect. In order to make an object stand out from its background, the brightness must be a minimum of two times greater, because the human eye is constructed in such a way that it is not able to notice difference if the brightness is less than twice as great.

Table 1. The Effect of Luminance Contast Ratio by Chartered Institution of Building Services Engineers (CIBSE) [27]

1:1	Not Noticeable
1:3	Just Noticeable
1:5	Low Drama
1:10	High Drama

3.2.2 Lack of integration with architecture (empty buildings)

Despite growing awareness of exterior illumination, there are still many random solutions in which the project of architecture and design of illumination are not consistent and pleasant. Therefore, these guidelines should be built into architecture where possible at the early stage of design, preferably at the conceptual phase. They shouldn't be viewed simply as engineering additions that can come later when they are often subject to compromise or are of inappropriate aesthetic design. Every building should be looked at and analysed initially in its own right and then in its context. Establishing a suitable relationship between a building and its illumination, between its nighttime and daytime appearance, is an

exciting challenge which should be thought through in detail.

Night time illumination of a building should give clear understanding of its function to help in visual legibility after darkness falls. Unfortunately, increasingly this is not the case. In certain urban environments such as Time Square in New York City or Piccadilly Circus in London, naming only few such examples, the property owners no longer rent their assets as offices or apartments, as the revenues generated by renting the frontages are far greater and easier to obtain than having tenants. Also, the overall brightness and light trespass does not allow residents to sleep. In such case architecture is losing its primary function – to be a shelter. Buildings are empty 24/7, hidden behind "luminous curtains". Such a façade is deprived of character and the function it initially had. Moreover, the overall brightness also leaves very little space for any other illumination of the architecture on the site. This approach creates chaos and lack of visual order.

3.3 Impact on natural environment

3.3.1 Light pollution

Light pollution is unnecessary, misdirected or obtrusive artificial light - a side effect of industrial civilization. It is present especially in large urban areas; it is most severe in highly industrialized, densely populated areas of North America, Europe, and EastAsia[28]. Pollution of this type makes it difficult to observe the astronomical sky, and has a negative impact on flora and fauna which have adapted naturally to life during the night; it can also have adverse effects on human health. The resulting phenomenon is mainly due to the operation of inefficient street lighting, advertising, illuminated sporting venues and other architectural objects, including Media Architecture and event lighting.

The luminance of Media Architecture is relatively insignificant during the daytime, especially when it is sunny. In order to be visible, its output must be very high. Unfortunately, very often its luminance is not reduced or switched off at night. To avoid the negative effects of light pollution and light trespass, CIE/ ILP defined the base for a well-designed external illumination (Tab. 2). These relate to such issues as acceptable levels of sky glow, light trespass into the windows of the façade and permissible average and maximum luminance of the façade. These should be also taken into consideration while designing Media Architecture. According to the guidelines, there are five environmental zones:

Zone E0 - protected – UNESCO Starlight Reserves, IDA Dark Sky Parks

Zone E1 - naturally dark landscapes - National Parks, Areas of Outstanding Beauty

Zone E2 - low brightness zone - small villages or relatively dark urban areas

Zone E3 - average brightness zone - small urban centers and urban areas;

Zone E4 - high brightness zone - town and city centers with high levels of activity at night.

Environ-mental Zone	Sky Glow ULR [Max %]	Light Intrusion (into Windows) Ev [lux]		Building Luminance Pre-curfew
		Pre-curfew	Post-curfew	Average, L [cd/m^2]
Zone E0	0	0	0	0
Zone E1	0	2	0	0
Zone E2	2.5	5	1	5
Zone E3	5	10	2	10
Zone E4	15	25	5	25

Table 2. Obtrusive Light Limitations for Exterior Lighting Installations by CIE/ ILP[29]

ULR = Upward Light Ratio of the Installation is the maximum permitted percentage of luminaire flux that goes directly into the sky.

Ev = Vertical Illuminance in Lux - measured flat on the glazing at the centre of the window.

L = Luminance in Candelas per Square Metre (cd/m^2)

Curfew = the time after which stricter requirements (for the control of obtrusive light) will apply; often a condition of use of lighting applied by the local planning authority. If not otherwise stated - 23.00hrs is suggested.

3.3.2 Flora and fauna

Studies conducted so far show that lighting installations (including Media Architecture) impact negatively on flora and fauna which have adapted naturally to life during the night[30]. Artificial lighting primarily interferes with the functioning of living organisms such as birds, fish, insects or bats. Excess artificial light, particularly visible light of different wavelengths can have a huge impact on the lives of nocturnal species upsetting their circadian rhythm. The preference of animals and insects for nocturnal activity may result from factors such as avoidance of predators, heat aversion, safer feeding or reproduction. Consequently, the color and changes in the intensity level of ambient light at night can lead to problems with reproduction, avoidance of suitable habitats and changes in seasonal migration routes, and even to a reduction in numbers and extinction of certain species[31]. As for flora, night lighting can have an effect on the shape of their leaves, their pigment, bud dormancy, the time when a tree drops its leaves in autumn or root system growth [32].

3.3.3 Global warming

Global warming is a currently observed phenomenon of climate change. It is caused by power plants which, as waste, produce large amounts of carbon dioxide and other by-products[33]. While many greenhouse gases occur naturally, human activity, including exterior illumination over the past 50 years, has repeatedly increased their level[34]. Global warming causes the climate to change and describes the increase in the earth's average temperature due to the build-up of greenhouse gases in the

atmosphere from human activities. Warmer global temperatures in the atmosphere and oceans are affecting rainfall patterns, storms and droughts, growing seasons, humidity and sea level. Climate change impacts more than just a change in the weather; it results in seasonal changes over a long period of time. It can affect many related aspects of where and how people, plants and animals live, such as food production, availability and use of water and health risks. Fearing visible and future climate change, governments around the world are looking for ways to reduce greenhouse gas emissions and the consumption of fossil fuels (coal, oil and natural gas) for electricity generation.

3.3.4 Energy consumption

In the context of exterior illumination, application of effective, efficient lighting is one of the first steps towards reducing energy consumption and the production of greenhouse gases. It turns out that about 30% of all U.S. outdoor lighting is directed at the sky, leading to a $ 2.2 billion loss[35]. This wasted light is wasted energy. As regards Media Architecture, some systems need a large amount of electricity to run, especially if they are used around the clock. Therefore, usage hours should be reconsidered and adjusted according to the time of day, season or special events.

3.4 Impact on human health

3.4.1 Increase in traffic accidents due to location of media architecture

Because the technologies used by Media Architecture are relatively recent, and for the reason that they have developed rapidly in key performance characteristics such as brightness, resolution, motion, colour, etc. and have become much more affordable in recent years, their impact hasn't been thoroughly studied. However, research conducted in the last 10 years which links the presence of electronic signage and advertisements with an increase in traffic accidents and lower road safety should be looked into[36]. As the latest LED technology enables the displaying of full-motion, real-time videos and graphics as well as sound, they are increasingly capable of "interacting" with approaching drivers, cyclists and pedestrians. "A distracted or inattentive driver is likely to have delayed recognition or no recognition of information necessary for safe driving"[37]. Too much visual clutter at or near intersections can lead to traffic accidents.

Therefore, safety information should have the highest priority. Moreover, it's commonly known that bright lights and visual change, especially at night, can draw the eye to an object that is brighter than other objects in its surrounding field of view (Phototaxis)[38]. Extreme brightness can not only cause disturbance but also compromise dark adaptation in elderly people, something which is important for viewing from long distances.

3.4.2 Artificial light at night (ALAN) and light trespass

Artificial light at night (ALAN) is a rapidly increasing phenomenon and it is acknowledged to have worldwide consequences[39]. Light at night has been associated with health problems in humans as a consequence of altered natural day and night biological rhythms. Light trespass is a common occurrence in the city at night time; it involves the "leak" of artificial light beyond the property or area that is illuminated, when spill light from a streetlight, illumination of architecture or advertisement enters a window and illuminates an indoor area.

Latest scientific medical research reveals that human health and wellbeing are profoundly affected by the intensity and different colour spectrum of natural light. In the morning there is a high intensity of blue (400-500nm), while in the late afternoon and early evening there is red and orange (600-700nm). In the late evening and at night humans need complete darkness or red wavelength light. Particular wavelengths of natural light during the day and night activate different sets of hormones and determine biological and biochemical activity of the human body and regulate natural circadian rhythm. So far, little is known by the general public about the non-visual effects of light. In 2001, a group of scientists at Thomas Jefferson University, the Department of Neurology, USA[40], identified a new photoreceptor type in the eye (ipRGC - intrinsic photosensitive retinal ganglion cells) which is different from rods and cones. This group of newly discovered cells is responsible for regulating the internal circadian clock in humans. These cells are sensitive in the blue light region of the spectrum [460-500nm]. When humans are exposed to white or blue light at night (the light produced by current LEDs and Compact Fluorescent Lamps [CFL]), the ipRGC sends information to the brain to stop the production of melatonin. This in turn adversely affects the immune system and triggers numerous biochemical processes. Melatonin production also significantly affects the regulation of anti-cancer (NK) and anti-germ (B) cells[41]. Humans require a properly functioning circadian rhythm and appropriate melatonin levels in order to repair and rejuvenate body tissues at night. Therein lies the problem; humans spend considerable amounts of time under artificial light sources, including outdoor spaces that cannot mimic the spectral content and levels of illumination of natural light.

3.5 Impact on the concept of national and regional identity, tradition and history of a place

More than half of the world's population at present lives in towns and cities and this figure is set to increase to 75 percent by the year 2050. This means they should still be designed for people[43].

Even though media architecture expands public space and generates new backdrops for existence in the metropolis, it's difficult to forget that human beings evolved in certain specific locations and have their own identity, tradition and history. What makes certain urban cities special and differentiates, for example, London from Paris, Berlin, Stockholm or Tokyo is their individual character, use of local building materials, architectural styles, how the city is used etc. These were designed and evolved locally.

Nowadays when renowned architects put forward their architectural or urban proposals, they look at the context of a place in the daytime. Why should this be different with Media Architecture at night-time? Globalization is affecting different parts of our lives, but will humans ever be ready for a global design solution for cities? Perhaps Media Architecture should relate more to its environment and not act as a showcase to another world, detached from place and time. Therefore in sensitive areas like historical centres such interventions should not be allowed as permanent installations.

3.6 General recommendations for improvement in the field of Media Architecture.

• Improvement of existing and creation of new standards and regulations with regard to Media Architecture.

• Media Architecture should never be considered as a stand-alone element of the urban environment but as an important part of a larger urban context. Therefore, its location should be integrated into a lighting masterplan.

• Yearly operational licences to evaluate Media Architecture, including its locations, content and performance characteristics could be introduced. This would permit the municipal authorities or any other decisive body to oversee its operations. Owners could be granted a license to operate a sign for a year and would have to renew the license if they wanted to alter the approved content or any of the performance characteristics.

• Avoidance of placing elements of Media Architecture such as media façades near intersections or other "busy traffic spots" to reduce distraction and promote better detection of traffic signs and other objects relevant to the driver's task. These elements are usually located on building elevations, at ground level closer to the approaching driver and placed at angles (especially on the corners of curved buildings) that may involve unnecessary head movement and eyesight effort.

• To minimize the negative effect on the environment, flora, fauna and human beings, it is necessary to control the overall level of illumination. A flexible lighting control system with a built-in astronomical time clock facility which can guarantee the right illumination at the right place at the right time should be employed. This uses location data such as latitude and longitude and also has a mechanism for the upgrade of the date and time of the year. Based on this information, it enables and disables the external lighting. After midnight (or some other specified time) the level of light intensity should be reduced or turned to "0" so that the potential negative impact on the urban environment can be greatly alleviated.

• No urban building or structure should have Media Architecture applied without reference to and thorough analysis of the context of a particular place.

• The content of media façades should be designed with the tradition and history of the place in mind.

4. CONCLUSION

As Media Architecture is expected to become an "increasingly important digital layer in cities all over the world"[44] in the near future and new technologies such as LEDs become more and more available due to their lower cost, left unrestrained it might create visual chaos in our urban environments.

If property owners are allowed to install this new medium without any constraint as lettable wall surfaces for advertisements with any possible content, a nighttime landscape of the city which resembles a combination of the cult films Blade Runner[45] and Metropolis[46] might be created. Such examples are already visible in Times Square of New York City or London's Piccadilly Circus where buildings are losing their previous function of being a shelter and becoming instead an empty shell created with a façade of "digital bricks"[47]. It must still be possible to design cities, allowing for diversity, but also at the same time creating balance and visual hierarchy.

Despite growing awareness of the external use of this new phenomenon, there are still many solutions that are completely random, in which the project of building architecture and design of Media Architecture do not form a cohesive, harmonious whole. Historical background and context of a place should be considered. Projects designed for Asia might not fit particularly well in historic parts of Italian cities etc. Also, in order that unique projects of Media Architecture can be admired in the same way as the first illuminated signs in Times Square, they need darkness in the immediate surroundings to be able to stand out. This darkness is also an important aspect as far as our nighttime skies, nocturnally active flora and fauna as well as our own well-being and safety are concerned.

One of the ways to minimise such negative issues might be for cities to implement lighting masterplans developed by professional independent lighting designers and commissioned by city representatives. After a thorough study of the city by day and night, they would set a number of important principles to be followed. Documents in the form of a set of guidelines would be helpful to lighting designers, engineers, architects (including media architects) and other members of the design teams responsible for the external illumination of cities and would give guidance on how to deal with problematic issues. These documents would also support planning authorities when new applications for Media Architecture are submitted.

In spite the fact that digital media are an exciting, new visual tool, a broader normative debate about what good practices in media architecture should consist of, with regards to the environment it operates in, should be considered.
As majority of people don't want to live in digital cities all the time, the words of visionary Andy Warhol might be very suitable today in the context of Media Architecture:

"The best, most temporal way of making a building that I ever heard of is by making it with light. […] If you build buildings with light outside, you can make them indefinite, and then when you're through with using them you shut the lights off and they disappear"[48].

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