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Displays for the Built Environment

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Abstract

“Media architecture” is a term for installations in which displays are integrated into architectural structures. In this chapter, we address five unique qualities of media architecture displays: *scale*, *shape*, *pixel configuration*, *pixel shape*, and *light quality*. We exemplify this through two media architecture displays, *Aarhus by Light* and *The Danish Pavilion* at Expo 2010, followed by a discussion of two key topics for such displays, namely, their integration into the built environment and the potential for interacting with them.

Introduction

Within the field of urban computing (Foth 2009), *media architecture* is a term for installations in which displays are an integral part of a building’s architectural structures (Haeusler 2009). (This chapter is based on the articles: Dalsgaard and Halskov 2010; Dalsgaard et al. 2011; Halskov and Ebsen 2013.) Media architecture is often implemented with LED displays and digital projectors, but the term has also been used to refer to dynamic lighting and mechanical façades, such as Jean Nouvel’s *Institut du Monde Arabe*, where iris-like shutters automatically open or close to adjust to the lighting conditions.

In media architecture, a number of genres may be identified: *advertising*, *brand communication*, *games*, and *art*. The buildings surrounding Times Square in New York, and Hachiko Square in Tokyo, are some of the archetypical examples of commercial advertising by means of media façades. The *Allianz Arena* football stadium in Munich, sponsored by Allianz, is a prominent exponent of the use of media architecture for branding purposes. *Blinkenlights* is a classic example of such an installation, where the windows of a high-rise building were turned into large pixels by placing a lamp behind each. The pixel matrix formed a low-resolution display, which was used for playing pong and displaying low-resolution animations. Artists are the driving force behind the creation of installations in the art genre of media architecture, as in the case of *Body Movies*, an installation by artist Rafael Lozano-Hemmer (Bullivant 2006).

Displays in the context of media architecture differ from conventional displays in several respects, as summarized in Table 1 (Halskov and Ebsen 2013). Whereas a conventional display commonly has a two-dimensional, rectangular shape, a media façade extends into three-dimensional space and may have any shape, including an organic form. The shape of individual pixels in ordinary displays is dot like or square and ideally hardly noticeable, whereas the shape of pixels in media façades is nonstandard, and often part of the visual expression of the façade. Moreover, the pixels in conventional displays are

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Table 1 Comparison of media façades with conventional displays (Halskov and Ebsen 2013)

	Media architecture displays	Conventional displays
Scale	Several meters	Centimeters, to about 1 m
Shape of display	Two- and three-dimensional	Two-dimensional rectangular
Pixel configuration	Not standardized	Grid or matrix
Pixel shape	Not standardized	Square
Light quality	Not standardized	Standardized

Table 2 Five specific qualities of media architecture display (Halskov and Ebsen 2013)

Scale
Scale is important to address in order to understand the size and volume of the building. In contrast to conventional displays, with dimension commonly measured in inches, media façades are huge. Most representations (drawing, models, and simulations) are scaled down to a smaller format, making it difficult to comprehend the actual scale of the media façade
Shape
Shape refers to both the outer perimeter of the media screen and the shape of the image surface. Whereas traditional displays are flat, rectangular surfaces, media façades may have any shape and even curve along the corners, bends, and curves of a building. This aspect is difficult to visualize on a two-dimensional computer screen
Pixel configuration
Pixel configuration is the layout or pattern of pixels on the media façade, which on traditional screens is a grid system of equal and perpendicular lines. Media façades, on the other hand, may use any configuration of pixels, creating complex patterns on a building façade. Translating media content from a conventional digital medium often requires techniques like subpixel sampling in order to accommodate the nongrid configuration on some media faades
Pixel shape
Pixel shape refers to the physical form of the pixels in the facade. Traditionally pixels are square shapes (preferable not identified as individual pixels), but on media façades the pixels can be any shape, determined by the lighting fixture or the architectural element that structures the configurations of pixels. On some media façades the pixel shape makes the visibility highly dependent on the viewing angle
Light quality
Light quality is crucial to how smooth colors are displayed, and how bright the media façade is. Brightness is mostly an issue of whether the media façade can be viewed in daylight or only in evening light conditions. The type of lighting fixture and the use of diffusers and reflectors may also produce visual qualities that are different form what traditional displays may produce

organized in a grid or matrix structure, whereas in media façades, there exists no standardized way of organizing pixels, see Table 1.

Although media façades act as displays, to some extent, their scale, integration into buildings, and context raise many questions that need to be addressed. In this chapter, we focus on two areas of design concern in media architecture: (1) interface and (2) integration into physical structures and surroundings, two of the eight main media architecture design challenges identified by Dalsgaard and Halskov (2010). The others are (3) increased demands for robustness and stability, (4) developing content to suit the medium, (5) aligning stakeholders and balancing interests, (6) diversity of situations, (7) transforming social relations, and (8) emerging and unforeseen uses.

In this chapter, we address five specific qualities of media architecture displays: *scale*, *shape*, *pixel configuration*, *pixel shape*, and *light quality* (see Table 2). We exemplify this through two media architecture displays, *Aarhus by Light* and *The Danish Pavilion* at Expo 2010, followed by a discussion of two key topics for such displays, namely, their integration into the built environment and the potential for interacting with them.

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Fig. 1 *The Danish Pavilion* at Expo 2010

Two Media Architecture Installations

The Danish Pavilion at Expo 2010

The Danish Pavilion at Expo 2010 was designed by the Danish architectural firm, BIG. The façade of the helical building was perforated by approximately 3600 holes of various sizes, which created an expressive surface that gave the building a characteristic visual texture. The façade was almost 300 m long, with a unique double-loop shape making the building appear as two stacked bands, one above the other, from some angles (see Fig. 1).

When our research laboratory, CAVI (Halskov 2011), became involved with the *Danish Pavilion* project, the idea was that the holes would be simple openings, but we suggested turning each hole in the façade into an individual pixel. The proposed solution was to furnish each hole with an LED lighting fixture behind a tube of semiopaque material, making each hole appear as an illuminated, *tube-shaped* pixel.

During the design process, several combinations of lighting fixtures and tube materials were tested, in order to investigate *light quality*, including color and intensity. A particular goal was ensuring that the PVC tubes diffused light uniformly. Owing to the three-dimensional form of the tubes, the *shape of individual pixels* depended on the viewing angle (see Fig. 2). The diverse size of the holes further added to the uniqueness of the display.

Owing to the helical shape and size of the building, the wavy *shape* and *scale* of the display was quite extraordinary. If unfolded, the display would have been 300 m long and 12 m high, with pixels organized in 627 columns, with a pixel distribution unique to each column. Moreover, the unique pixel *configuration* had an aspect ratio of 25:1, which is 13 times wider than what we normally define as "*widescreen*."

The pavilion's' *scale*, combined with the extraordinary *shape* of the display, the individual *pixel shape*, and irregular *pixel configuration*, imposed serious limitations (Biskjaer and Halskov 2014) with respect to the types of *content* it made sense to show on the low-resolution display. The low resolution excluded the possibility of displaying conventional video, and the irregular *pixel configuration*, with its lack of

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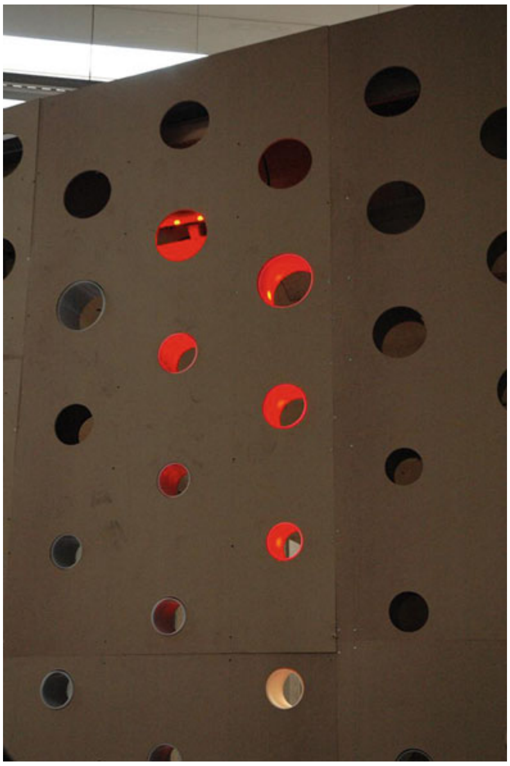

Fig. 2 Mock-up for testing the individual pixels during the design process

Fig. 3 Content on the low-resolution display

horizontal lines, made traditional geometric figures very hard to perceive. The final content was limited to white surfaces broken by lines, fades, or silhouettes of people walking or bicycling along the façade. For the dark evenings, the fixtures faded to a warmer color, and a show reel of animations was displayed on the façade, including shimmering, abstract graphics, sweeps, fades, and animations along the entire length of the façade (Halskov and Ebsen 2013), see Fig. 3.

Aarhus by Light

Aarhus by Light was an interactive media façade at Musikhuset concert hall in Aarhus, Denmark, which was installed and run 24/7 for 2 months in 2009 (Dalsgaard et al. 2011). The *scale* of the media façade

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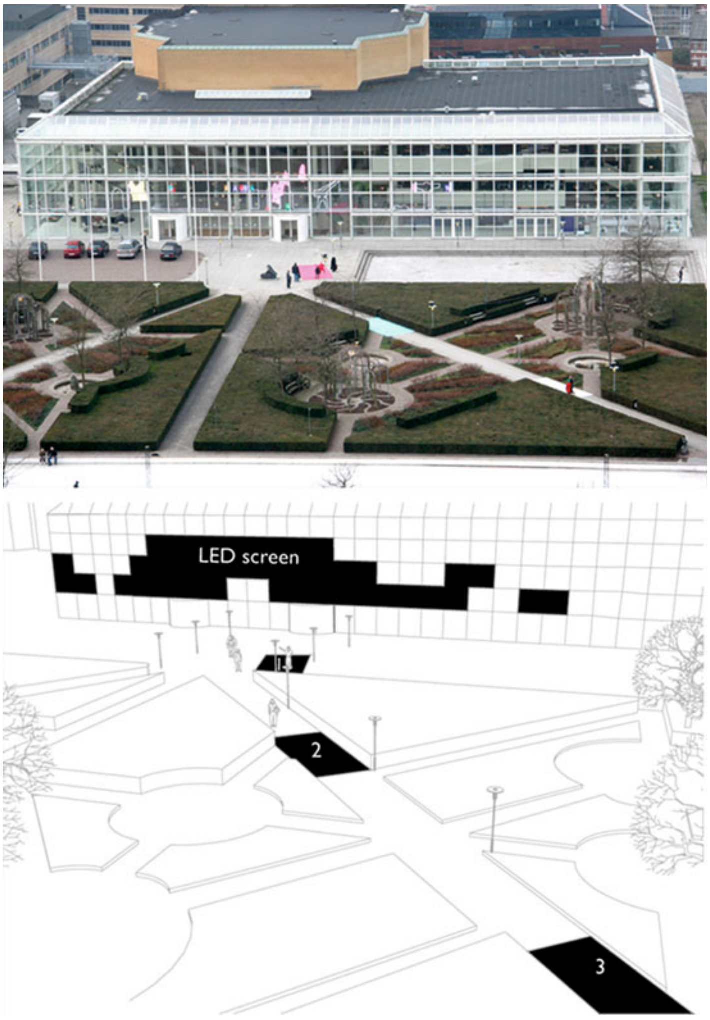

Fig. 4 Musikhuset concert hall with the media facade installation and the three interaction zones in the park

was, for that time, very large, 180 m^2 (1937 sq ft), integrated into the 700-m^2 glass façade of the concert hall, which is located in a central public park. The installation was developed through a partnership between our research lab, CAVI (Halskov 2011), and the lighting company, Martin Professional, with additional interactive visuals developed by the Animation Workshop, Denmark.

The installation was developed to attract attention to the award-winning concert hall building and to enrich the experience of the park, which at that time was mostly a transit area. At the same time, it served as an experiment in how interactive media architecture could affect and transform social relations in a public space. As a consequence, the installation was designed to run evolving, interactive content, rather than prerendered visuals, and to offer park visitors and passers-by the means with which to interact with the façade in an accessible and easily recognizable manner. The latter aspect was accomplished by developing software to detect and track the silhouettes of people in three designated areas of the park, so-called interaction zones, so that people could interact with the façade solely by moving about and gesturing.

The *pixel configuration* of the display consisted of panels composed of 25 $\times$ 50 pixels (4 cm dot pitch), which were assembled in a display of 1250 $\times$ 150 pixels. The rectangular LED panels matched the existing glass façade modules of the concert hall. The *shape of the display* was configured as an irregular form measuring approximately 50 $\times$ 6 m across the front of the façade, facing the park, see Fig. 4.

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Fig. 5 Luminous creatures inhabiting the building and the city skyline

A small portion of the display was placed on the side of the building, creating the impression that the display stretched around the entire building. We chose this shape to purposely go against the traditional, rectangular form of most displays, and thereby indicate to observers that this installation was beyond the ordinary.

The installation displayed three forms of content. First, and most prominently to passers-by, were 30 so-called luminous creatures, which moved around the structure of the building, seemingly inhabiting it. Each creature was autonomous, guided by a set of algorithms with a degree of randomness, to create emergent and never fully predictable patterns of movement and interaction. Second, and less prominently, a skyline of prominent local buildings and structures was rendered in the background, to establish a relationship to the city. Third, silhouettes of passers-by and visitors to the concert hall were captured via cameras in dedicated areas in the park and displayed on the façade, see Fig. 5.

The installation was designed to offer an intriguing experience for people in the park, by drawing them into the installation. When people entered one of three designated interaction zones in the park, their silhouettes appeared on the façade, Figs. 4 and 5. This enabled them to interact with the luminous creatures. The creatures would exhibit different behaviors, such as waving and greeting the silhouettes, being pushed away by them, crawling onto them, jumping off them, kissing them, kicking them, and so on. In so doing, we sought to establish temporary relations among the various luminous creatures and the visitors to the park. Although the behavior of the creatures was to a large extent randomly determined by the underlying algorithms, we found that many visitors created coherent stories about the interaction, to make sense of the installation. Furthermore, many visitors would interact with each other's silhouettes, for instance, by engaging in shadow boxing or playing "catch."

In addition to the display being physically integrated into the façade, the integration of the display into the building was supported by having the content relate to the building, for instance, by having the luminous creatures crawl up and down the steel framework or entering or exiting doors at the frames of the façade, Fig. 5.

Discussion

Integrating Media Architecture Displays into Buildings and Spatial Surroundings

When it comes to developing media architecture displays, two principal and interrelated challenges are to determine how to integrate displays into physical structures (typically, buildings) and how to establish a

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suitable fit with the surroundings, that is, the landscape, as well as the built environment. The introduction of a new piece of media architecture may constitute a radical intervention into existing architecture and spaces and into the sociocultural situations and routines that unfold in them. This may obviously affect a specific building into which media architecture is integrated, for instance, when a building façade becomes a display. It may also affect the surrounding space less obviously, for example, when huge displays catch the attention of people in the space and alter their behavior.

There are various strategies for integrating media architecture displays. They may be designed as an integral part of a façade, as we see with the *Danish Pavilion* and the *BIX* façade of Kunsthaus Graz. Such integration usually requires media architecture designers to be part of a project from the very early stages. This may make it easier for designers to establish a strong and meaningful fit between the interactive installation and the intended form and function of the building. On the flip side, deeply integrated media architecture displays may be very costly to upgrade and change. Digital technologies change at a much greater pace than architecture, and therefore, this approach may lead to installations that appear dated, unless their appearance and behavior are thoroughly considered and developed to suit the building.

Another strategy for integrating media architecture displays is to integrate them into existing architecture, as seen with *Aarhus by Light*, or in spaces such as Times Square, where displays are attached to existing buildings. In many respects, the benefits and drawbacks of this approach are opposite to those associated with the integrated display approach, described above. They may be replaced frequently or updated at less cost and without compromising the existing building. However, it may be harder to establish a good fit with the existing building. If we consider the example of Times Square, the displays may give the appearance of being plastered onto existing buildings. However, the *Aarhus by Light* example illustrates that much may be done to create a better fit with existing architecture. In this case, LED panels were fitted into steel lattices of the building, matching the existing window panels. Also, the LEDs were distributed so that the display appeared semitransparent. This meant that in daylight, and when the display was turned off at night, the display was barely perceptible. Integration into the existing form of the building was further enhanced by programming the luminous creatures to walk along and crawl up and down the lattices of the building.

Interacting with Media Architecture

A key feature of media architecture displays is that they enable designers and architects to reconfigure the relations between people and architecture by developing ways for people to interact with the displays. However, a primary challenge when designing such displays is that we can seldom rely on well-known, off-the-shelf technologies to capture user input. Instead, designers often have to modify and/or develop new types of interfaces. Although this may change as media architecture becomes more widespread, currently, designers must consider not only the implementation of the display and development of prerendered content for it but also the development of interfaces and dynamic content suited for interaction.

The *Aarhus by Light* case illustrates these challenges. In terms of designing and implementing the interface, we had to develop an input form that could be operated by anyone in the park, and to design content that would respond to this input in a way that required little or no learning, or preexisting knowledge. For this reason, we developed a camera-tracking system, installed in weather-proof housing and mounted on top of existing light posts, that could capture the three interaction zones. The video feeds were then processed, to isolate the silhouettes, in order to create forms that park visitors could immediately recognize, and whose movements they could quickly link to their own movement.

As the field matures, we may expect to see more of abovementioned technologies in an accessible form that will be easier for designers and developers to implement, but at the moment, most interactive media architecture displays rely on a combination of custom-developed software and hardware.

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A similar logic applies to the content of media architecture displays: As we have discussed, they differ from most traditional displays in terms of properties such as scale, resolution, brightness, exposure, and shared use. In our experience, this means that often, you have to scrap your preexisting knowledge of which content will work on a display, and how to interact with it. In effect, media architecture displays are a new medium – just as a smartphone is a different medium than a traditional computer – and in most cases, copying existing content and interaction forms does not lead to good results. Instead, we must reconsider which forms of content it makes sense to present on and through architecture, and how people may meaningfully interact with it, given the opportunities and constraints these large displays and their placement encompass.

Further Reading

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