Interactive Wallpaper

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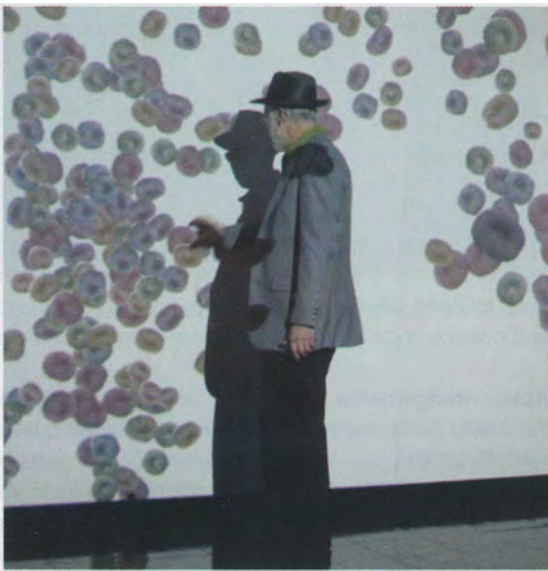jhuang@gsd.harvard.edu
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Figure 1 Sample interactive wallpaper prototypes in action at Sever Hall.

ABSTRACT

Interactive Wallpaper represents a new category of digital art. Deeply embedded into our built surroundings, interactive wallpapers exhibit the following characteristics, blurring the boundaries between decorative art and useful science:

1. They operate in everyday life
2. They are open
3. They are spatial.
4. They are alive.

Interactive wallpapers combine these primitives into powerful "immaterial" building blocks for creation of future spaces, buildings, cities. In this paper, we present a series of interactive wallpaper prototypes in order to explore how the tectonic and psychological effect of our surroundings can be augmented, subverted, and estranged by animating wallpapers and introducing an interactive, possibly darker dimension into architecture. What happens when traditionally static and innocent wallpapers become alive, get a sense of memory, spatiality, connectivity and randomness, and become part of our everyday lives?

Introduction

Around the turn of the 21st century, digital networks, like viruses, began to spread and infiltrate the last bastion of the physical order and challenge architecture as the de facto shelter for protection and privacy.[4] Architecture thus challenged reacted vigorously, albeit slowly, resisting a complete takeover, and temporarily blocking the digital intrusion. Left hanging in the air, digital networks deviated into wireless ether and began to pervade humans' mobiles and wearables, absorbing anything portable anywhere.[6] From the beginning, however, it was clear that architecture's brave resistance could not last forever.

Architecture is now being forced gradually, building block by building block, to abandon its traditional purity and solidity and finally get wired. In this paper, we trace this transition from physical architecture to wired architecture by recounting the story of one particular building block: the wall, and especially its veneer: the wallpaper. We discuss how the tectonic and psychological effect of our surroundings can be augmented, subverted, and estranged by animating wallpapers and introducing an interactive, possibly darker dimension into architecture. What happens when traditionally static and innocent wallpapers become alive, get a sense of memory, spatiality, connectivity, and randomness, and become part of our everyday lives?

We examine such questions through the lenses of architecture, which traditionally has operated at the intersection of art and s science method is a critical investigation of media-influenced changes in environment, followed by hands-on prototyping of new and estranged spatial objects that operate in everyday life.

Interactive Wallpaper

Interactive wallpapers differ from more traditional digital art forms, such as computer graphic images, renderings, and animations, along the following four dimensions:

1. They operate in everyday life. Interactive wallpapers are not stand-alone objects to be exhibited in galleries, nor functional applications, but situated spatial elements that are integral parts of everyday life. Estranging familiar, space-defining elements, interactive wallpapers appear at the periphery of attention, liberated from habitual routines of uses. They are inhabitable, embracing and surrounding the everyday citizen.

2. They are open. The wallpaper designer shares authorship and control of the art work with the user. The viewer's and the inhabitant's presence and input completes the experience of the interactive wallpaper. An unpredictable canvas of possible interactions, interactive papers are never the same, changing in time based on external interaction.

3. They are spatial. Interactive wallpapers are distributed in space. are organized around their own geographies, at their own scale resolution. Escaping the conventional separations of ceiling, floor, wall, interactive wallpapers liquefy space-defining boundaries offer a new freedom.

4. They are alive. They are responsive and in constant flux, like a sun clock, only without the linearity and predictability. They sometimes play a more obscure role, that of a friend, a filter vis-a-vis the exterior world. They remember things, events, and people. Recognizing people, wallpapers are able to respond in a personal fashion. They give an illusion of a certain form of intelligence and autonomy, surprising comforting at expected moments.

Precedents

From the perspective of the history of architecture, interactive wallpaper is a new and largely unexplored design territory. The idea of wall surfaces as a visual interface is, however, not new. Architecture and wall surfaces as interfaces for communication have been known and used throughout history.[3] From the cave paintings and Plato's cave to rich and iconic illustrations on the walls of temples and churches in medieval and Renaissance architecture, we encounter architectural surfaces employed as projection surfaces for communicating and beliefs in different cultures and different times.

Beyond passive surfaces that carry images and stories, walls as interfaces have been investigated more actively since the Renaissance. In the mid-17th century, for example, Athanasius Kircher, the Jesuit savant, proposed what could be seen as precursors of interactive wallpapers. His projects include architectures in acoustical and visual interfaces were seamlessly integrated into the walls. A particularly illustrative example is the "Klangschnecke," a building proposed around 1650, in which walls operate as sonic interfaces: spaces are connected by winding acoustical interfaces. Standing in a side chamber, hiding behind a statue, one may overhear a conversation happening in the adjacent big hall, or spread by whispering secrets into the wall interface.

The advent of digital media changed the notion of walls as interfaces in the 20th century. The IBM Pavilion in New York. "Think" (designed

in 1965 by Ray and Charles Eames), provides a good example of an attempt to merge information, digital media, and architecture into an integrated structure. Later dubbed the "information machine," the pavilion remains an important precedent for a new kind of architecture that results from a deep concern with information organization, retrieval, and use.[1]

Interactive wallpaper builds upon and extends this tradition of wall interfaces. What distinguishes interactive wallpapers from the precedents are, as the name suggests, the facts that they are interactive and that they are wallpapers, applied onto walls, with the flexibility and transportability those characteristics imply.

Wallpaper Technologies

To explore the range of possibilities and better understand the nature of interactive wallpaper, we present in the following sections sample interactive wallpapers that we prototyped in our new digital design studio at Harvard University in collaboration with student researchers. In terms of software, we used Director/Lingo, Flash/Actionscript, Java, and Logo. In terms of hardware, we used off-the-shelve sensors, actuators, projectors, and micro-chips. The innovation is in creative aggregation and poetic application of technology rather than invention of singular technology elements.

William Morris Wallpaper

Our first example is the fruit-and-flower wallpaper based on an original arts-and-crafts design by William Morris. The fruit-and-flower wallpaper decorates the walls of spacious salons and halls. Light yellow lemons and red blossoming flowers hang on the branches of a tree. Green leaves provide a colorful backdrop for the unfolding scene. This magnificent wallpaper reminds us of a time of siestas and endless meals, when we imagined a thousand stories while l ooking at the wallpaper. The rich ornaments suggest a hidden life behind the wallpaper. The lemons lightly balance on the branches. Some lemons appear to be more mature than others, and the branches seem to be shaking subtly. A lemon falls to the ground, probably overripe.

Minutes pass, hours pass, and the wallpaper changes, telling its story and also speaking of the seasonal and weather conditions outside and the passing time. The interactive fruit-and-flower wallpaper has been programmed to have a memory and a behavior deeply associated with the geographical and temporal conditions of the location where it is situated. The wallpaper changes color when it senses changes at its location. It recognizes the presence of humans and remembers the passage of certain people. Coincidences, accidents, and hazardous events are all part of the wallpaper program and guide the behavior of the fruits, flowers, leaves, branches, and colors, transgressing the routines of habitual life. This wallpaper is well-meaning, containing pieces of information that are disguised to the public eyes. The underlying information is visible only to the passengers who know the code.

Figure 2 The William Morris wallpaper estranges the room it inhabits, exhibiting an Alice in Wonderland quality. Did it happen or not? Did the flowers become larger? Did the leaves jitter slightly?

Word Map Wallpaper

Interactive Wallpaper #32: Word Map is a different category of wallpaper that complements the visual sense with the acoustic. We created the piece in 2003 for an installation in Cambridge, Massachusetts. Located in the main foyer of the Carpenter Center, this wallpaper remembers conversations happening in the space. Microphones capture snippets of conversations and turn them into floating text that appears on the interactive wallpaper. The text swirls on the surface of the wall, and sinks, fades, and scales gradually to become sediments of thoughts on the floor, indicating the presence and traces of human interaction over time. As visitors approach the memory sediment, the individual words sense the warmth of human presence; and the words move slowly toward the visitors, curiously attracted by their bodily activities.
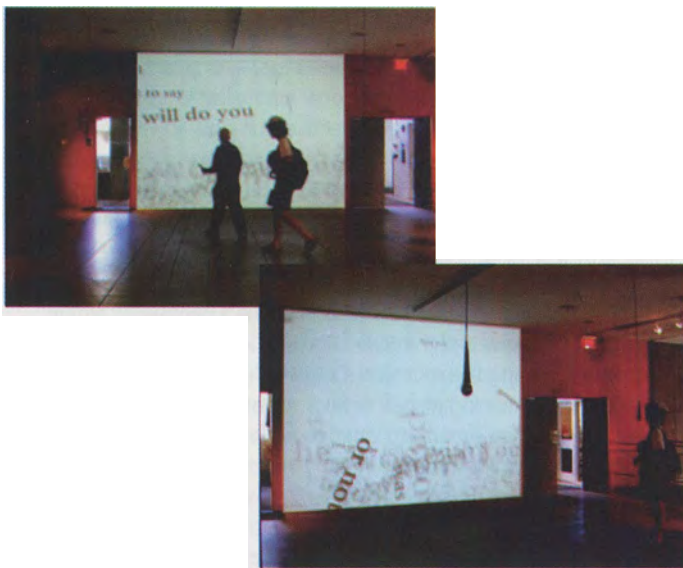

Figure 3 Word map. The walls of the Carpenter Center become a memory container of conversations.

The wallpaper is simultaneously co-constructed at a distance. Visitors can interact with the wallpaper via the internet by typing in words that appear on the projected wall. The hall transforms itself into an archive space, capturing the memory of the moods and thoughts of the day. At the end of each day. The ensemble of words can be printed out as daily poems that are the memory of the intellectual discourse happening in this place, physically and virtually. The piece shows how simultaneously recordings in the space, expressions from the web and interpretations and misinterpretations from the computer combine to create a spatial composition of words that reflect upon the various kinds of information inputs that co-exist in everyday life. The interface devices – microphones, webcam sensors; projectors – are visibly exposed to make the presence of the machines known. The machines are not spying, or secretly recording conversations and intruding privacies, but rather are conversational partners actively listening to visitors.

Haptic Wallpaper

A different idea informed a series of other wallpapers that go beyond the visual and acoustic. Overwhelmed by a world of images, text and sound and the domination of the visual over the other senses, this series started with a desire to confront the bod's loss of sensibility in front of the screen. How can the tactile and olfactory senses be integrated to enrich visual and auditory perception? How can other senses be evoked to open up a powerful world of more unconscious and visceral responses, of feelings and emotions? How can we create inhabitable media that make us be afraid, exult, feel pleasure and suffering? Such emotions are felt by the body; they can be evoked directly by the choreography of the different senses or associatively by tapping into our tactile memory.
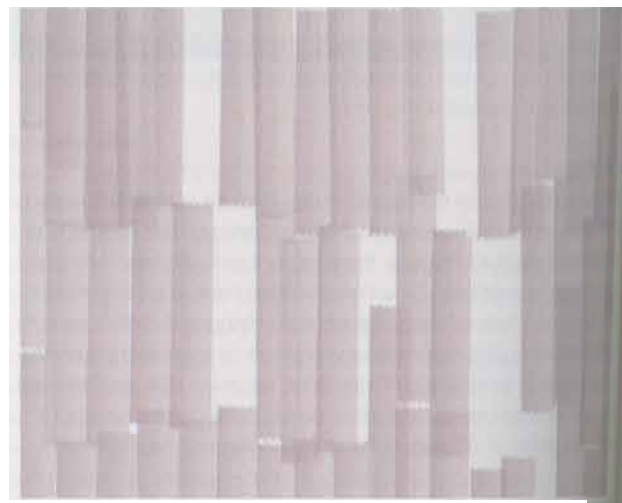

Figure 4 Haptic Wallpaper. The haptic wallpaper encompasses the tactile senses of perception, inviting the viewer to scratch the surface.

Digital Tape is an example of this kind of wallpaper. The interactive- digital-tape wallpaper taps into our tactile memory. In this piece, wall is a projection of fragments of semi-transparent adhesive tapes. The tapes appear to hide something precious behind its translucent veil. In order to go beyond the surface, however, it is necessary to remove the adhesive tapes. The interactivity is not symbolic here There are no iconic buttons inviting us to participate. Our engagement comes spontaneously from our tactile understanding of the wallpaper. We automatically feel compelled to scratch the surface with certain gestures. We begin with one corner and scratch that corner slightly with our fingers and fingernails in order to remove the

adhesive tape. This knowledge of the right gestures (the "scratch" movement) is innate in us, impregnated in our memory through time, childhood. We all have once scratched an adhesive tape, and our tactile memory has registered these gestures. Incorporating the body in our interaction with the strong and rational computer, the haptic wallpaper makes our media experience sensual and natural.

Skin-Deep Wallpaper

Skin Deep takes the tactile dimension one step further. It deals with interactive wallpapers that go beyond the screen, when media are no longer projected onto a material surface, but the material surface itself becomes animated. In a time when computer chips, sensors, actuators have become increasingly small and inexpensive, it is inevitable that there will be more and more informational devices surrounding us, infiltrating our daily lives. What should these new elements of our everyday environments be? Will they have a life of their own? Do we want them to have a life? Who or what controls them? How are they changing the way we practice our daily activities? Are they reflecting, subverting, or enriching the way we act in various contexts? How are they estranging our feeling of intimacy and closeness?

Skin Deep explores such questions by taking elements of the built environment and giving them a certain "depth" and interactive potential.

Samples include:

Affectionate Velour. The affectionate velour is an interactive material that develops a relationship with its user over time. The velour reacts by caresses by emitting unfamiliar noises. It remembers the type of caresses and may ask for more. An inanimate object, the velour takes on a life of its own.

The Water Wall. The Water Wall prototype uses falling water as an architectural barrier by forming a thin water curtain and emitting the sound the water makes. Sensor technology allows users to pass the wall in certain instances without getting wet; at other times, users can interact with the water but cannot pass through without getting soaked. The water wall introduces fear, evoking the displeasure of getting wet. The body is involved.
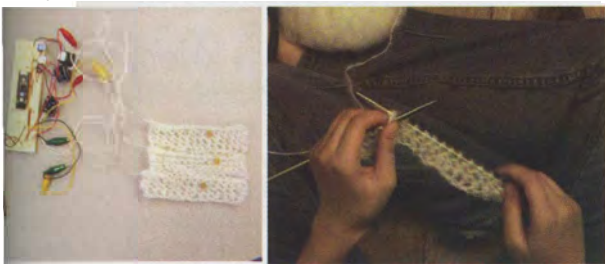

Figure 5 Interactive Fabric made of electro-luminescent wires (elwires) interweaved with angora hair. The fabric lights up when touched and down over time.

Interactive Fabric. The interactive fabric uses traditional crocketing techniques to interweave angora hair with electro-luminescent wires) and embedded touch sensors. Soft and inviting to the touch, it is also connected, electric, responsive. The interactive fabric

lights up gradually when you touch it and fades down over time. The blanket makes it seem as if a person is warming it as opposed to it warming a person. Rather than bringing warmth and security, this blanket emits an unsettling electric light and sound.

Lightwall. The Lightwall was developed as a subversive alternative to two architectural details: the light switch and the wall. When viewed as a freestanding piece, the outside world is visible, though filtered through layers of screens, wires, fabric, and light. The light wall can be turned on by tracing with the hand the area to be illuminated. This intuitive one-tone correspondence is shaken when the same area is approached again.

Lichtenstein Wallpaper

The painting of Lichtenstein is revisited, redrawn with today's tools and incorporated into an interactive wallpaper. The Lichtenstein wallpaper is interactive: the dots in the painting respond to viewers and enhance their experience of the painting. Each dot is programmed to have its own (interdependent) behavior: it moves, contracts, jitters.

The dots are contained within the contour lines of the drawing and are not allowed to escape: they belong to a specific area (for example, the blue dots belong to the eyes and tears, the orange dots belong to the nose and eyelid, and so forth. As the viewer approaches the wall, the dots become smaller in proportion to the distance of the viewer, creating an interesting optical effect: the size of the dots (the granularity and resolution of the image) feels as though they remain always the same. Finally, when the viewer moves very closely to the wall, the dots start moving away to the corners and along the lines of the drawings, leaving an almost blank contour. The behaviors of the dots give life to the painting and are strongly responsive.

Figure 6 Lichtenstein Wallpaper. Each dot has its own behavior constantly interacting with the contour lines, the viewer, and neighboring dots.

Perhaps Lichtenstein might have approved of mathematically programmed dots. As an artist, he always tried, at least conceptually, to give an industrial and mass-manufacturing quality to his paintings even if in reality he was painting each little dot with a paint brush. Here the dots are programmed to duplicate themselves, fade away, move the lines of the drawing with their full weights.

Digital Shadows Wallpaper

The shadows piece is a collection of remembered interactions

between two people. The interaction is frozen in time, and the frozen statues become temporary traces of people on the walls of the room. Similar to an antique frieze illustrating the sentences and gestures of protagonists and antagonists, the silhouettes recount the brief stories of heroes and encounters. The set of shadows slowly fades away after a few hours.

When two or more people have an intense discussion, a sensor detects their strong movement and gesticulation, and a camera takes a snapshot. The image of the snapshot is transformed into a gray-scale image that reveals the beauty of the movement. However, the faces and identities of the actors remain difficult to discern, so they do not violating the private realm. As one enters the room of shadows, the shadows of recent encounters are superimposed and provide a backdrop to actual activities. The various shades of grey create a living memory of body interactions in space.

Figure 7 Digital Shadows wallpaper: visual layering of interactions and encounters through time.

Conclusion

We have presented several early prototypes of interactive wallpapers. The work started with the desire to converge physical and virtual architecture and articulate potential directions for media art when it is no longer flat. Clearly, these are still early examples of what could be; we are only beginning to understand what the real opportunities and challenges are, but the examples seem to be already indicative of the directions where this could be going.

A common pattern that links the examples together is the way we view digital media and computers: no longer a stand-alone static painting but an interactive surface that is part of the environment, computers are seen as a social and spatial device. It is important to stress this social and spatial aspect of digital media. First, the computer is no longer our grandparents' mainframe or our parents' desk-top calculator, it is a social device, a window to other places and to other people, an inhabitable place for creating communities based on shared affinities.[2] And secondly, it is a spatial device. The computer is emancipating and liberating itself from the beige, plastic (or translu-

cent) box and becoming part of our everyday environment, augmenting, possibly subverting familiar everyday objects and surroundings.

With this shift to a view of the computer as a social and spatial device, architecture can no longer remain an impatient, yet passive place where computing happens, but must rise to the occasion and become an active communicative vector, an interactive medium itself an entryway to virtual space, and a surface for interactive play: an inhabitable interface that not only responds to body interaction but also connects to other places, and filters and orchestrates information flows.

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