Sensory Anomalies
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Mediated Sensory Experience
The work discussed in this chapter can be seen as experimental design research, exploring formal aspects of time, space, place, movement and perception. The nature of mediated sensory experience is central to such explorations.

Mediated sensory experiences are never perfect, in terms of being indistinguishable from unmediated first-hand experiences. These imperfections, the sensory anomalies, range from distractions and violations to poetry and metaphor, depending on the complex relationships between media, content and audience. For new media, these relationships are largely unexplored: we learn as we go.

The single biggest difference between first-hand and mediated experiences is whether sensory anomalies exist. There are none in first-hand experience. Such anomalies always have explanations: the window allowed me to see but not hear, the ventriloquist is talking not the dummy, and the elevator changed floors when the door was closed. The physical world obeys the laws of science. When we experience anomalies in the physical world, it’s due to human hardware or software issues, such as blindness or psychosis, not because of the environment.

Now consider montage. In the blink of an eye, the movie audience is transported across space or time, an entirely impossible event in the physical world. The same holds for optically changing scale, for compositing together different audiovisual elements, and for generating photo-realistic fantasy characters and places. We would question our senses, or our minds, if we saw a giant human head staring through our living room window, or if we came upon the Eiffel Tower in a cornfield, or if Bugs Bunny hopped by. But we totally accept, indeed enjoy, such anomalies in the movies and in other media. These anomalies are intentional, meant to create metaphor and poetry.

“Virtual Reality,” in its theoretical construct, is the merging of the feeling of first-hand experience with the freedom from physical-world constraints. The ultimate VR experience may have dungeons and dragons, it may have “cartoon physics,” or it may simply transport us to another place or another time. In all cases, the goal is indistinguishability from first-hand experience in the physical world: “just like being there.” Such VR doesn’t exist and may never (at least not without electrodes). So for now, we live with even the best sensory media having some degree of anomalies. These anomalies are not intentional, and entire industries exist to make higher resolution cameras, better synthesized lighting models and auto-stereoscopic displays. The goal is not about creating metaphor and poetry but about re-creating a multi-sensory experience that is as consistent as possible.
So some anomalies in sensory media are intentional while others are not. What gives?

Rather than propose Big Answers, I present here a series of small observations. Over the past two decades I've explored how new media technologies can expand "sense of place."

These projects, being experimental in nature, have been opportunities to both transcend and exploit sensory anomalies and to watch what happens. Here are some notes and observations about these projects from which readers may draw their own conclusions.

**Anomalous Space**

**DOME PROJECTIONS**

Like montage, mediated experiences may offer ways to experience space one might consider superior to unmediated experiences, anomalies be damned. Some work, some don't, and there's no way to know except by experiencing them.

In 1978, as a graduate student at MIT, a visual riddle became a haunting obsession. Suppose one placed a 180-degree lens on a camera, pointed it straight up and shot a picture, then projected it onto a dome with the same fisheye lens. For viewers inside the dome looking outward, the image would more-or-less "read" correctly. But what if the image was projected on the outside of a little dome, and viewers were outside the dome looking inward?

My obsession, particularly at a place like MIT, became contagious and the subject of cocktail chatter. Some of my colleagues thought the image would look as natural as sitting in a planetarium but from a "God's eye" view. Others were convinced the image would be gobbledygook.

So for the next month, I built a simple camera and display system. I rented a large, expensive fisheye lens, mounted it on a Nikon 35mm still camera, and shot lots of images in a variety of settings and situations (more on this in a moment). The metal back of the camera was replaced with a custom-made optical glass mount and the camera was mounted vertically with a strong light source underneath aimed through the glass. A 36-inch acrylic dome was sandblasted to act as a rear screen, mounted on top of the lamp/camera/fisheye lens system, and the processed film was reloaded into the camera. Voilà, an inside-out dome projection!
The documentation image shown here may look impressive, but the reality is that poor Ann Marion, another MIT graduate student, sees nothing: her eyes are straining to focus close-up on imagery that is far-field, and the image itself is curving in all the wrong directions. Some observers claimed partial success for interior imagery, where the wall and ceiling lines along the dome’s surface could be mentally “flipped” like the Necker Cube illusion. But for the most part, there was no miracle “inside-out” illusion many of us hoped for.

The Dome Projection did have one noteworthy feature, though. At the time, I was involved romantically in an intense but confusing relationship. During the week of shooting, there we were, standing in an embrace, when I reached for the camera, placed it between our faces, and snapped. The image projected on the dome shows her face on one side and mine on the other. If this were projected inside a planetarium, we would indeed be facing each other, but on my little dome projection, we appear to each be facing away, backs to each other. “I guess this sums up our relationship,” she said upon seeing it.

**DISPLACEMENTS**

During the same period, I was exploring how to add spatiality back into cinema by moving the projector the same way as the camera moved during filming. That movie cameras can move but movie projectors don’t is itself an anomaly, and when a movie projection moves the same way as the original camera movement, a very natural-looking “flashlight effect” occurs. A simple demonstration can be made by filming with a movie camera on a slowly rotating tripod, then projecting the movie on a slowly rotating turntable. This became the basis for an art installation.

The idea was to design an Americana-style living room, mostly from Salvation Army furniture, inside the exhibition space, then film it with a rotating movie camera from the room’s center. After filming, only two changes were necessary: the camera would be replaced with a loop projector on the same turntable and the entire contents of the room would be spray-painted white. The projector would project everything back onto itself, now acting as a giant, custom-shaped projection screen.

Projecting an image onto a screen the same shape as the image enlivens it to perfect three-dimensionality. Such a technique is used by Disney in the Haunted Mansion to project a woman’s face onto a face-shaped mask. This effect is so strong that small anomalies, such as her moving lips, go unnoticed. Most people erroneously believe they’re viewing a hologram (which, to anyone in the field, is nonsense).
I produced this living room installation three times over a four year period, each time walking the plank a little further away from verisimilitude in favor of sensory anomalies.

The first installation, obediently entitled Moving Movie, was almost entirely motionless, insofar as the rotating movie projector simply projected rotating imagery of the stationary furniture that occupied three of the four walls. In what felt like a total violation of the concept, I filmed a performer walking along the fourth blank wall. Though she added some motion, and maybe even some emotion, she appeared simply as a flat projection in an otherwise 3D projection environment.

The following year I produced the installation again, this time deciding to integrate live performance even though I was apprehensive of the anomalous look of people in the movie (especially knowing that I could not paint them white as well). This second installation, with another general title, Movie Room, also had one blank wall, where three performers did such actions as spray-painting graffiti as the camera panned by. One insisted on actually sitting on the sofa during filming, to which I finally succumbed. Another snapped a Polaroid picture and stuck it on one side of the blank wall during filming. I decided, after a great deal of “art anxiety,” to keep the Polaroid unpainted. In the end, I was indebted to the performers. The graffiti action was striking but safe. The performer on the sofa appeared nicely ghost-like (an anomaly!) on top of the very real-looking sofa. And the image of the performer holding the image of the Polaroid, walking toward the actual Polaroid, and placing it there—witnessing the moment where the image and object became one—was spine-tingling.

This displacements/convergeance anomaly became the basis for the third installation. This time, no holds were barred on violating the formalism of 3D representation. Another living room was installed, this time along all four walls. Lots of movable props: sweaters to take off, a purse, a globe to spin, junk food on the coffee table. Two performers were carefully scripted to move things during filming. Ten rotations were filmed. This installation was still about adding spatiality to cinema with the rotating and 3D projection, but it was also about the displacements. The piece, entitled Displacements, was final.

Anomalous Time

MOVIEMAPS

A motion picture film can be viewed forward or backward at any speed, even though there’s only one “correct” (non-anomalous) speed, at least if “real-time” playback is the goal. But motion picture film can be triggered by space instead of time, measuring “frames-per-feet” instead of “frames-per-second.” Such is a “moviemap.”

A moviemap is a kind of interactive travel experience made by carefully pre-recording paths and turns, then accessing the material in such a way to give the participant control of speed and direction. The first moviemap was made of
Aspen, Colorado, by filming up and down every street and filming every possible turn through every intersection, using a special camera on top of a moving vehicle, triggering one frame every ten feet by a fifth wheel. The camera vehicle drove down the center of the street, and filming took place between 10am and 2pm to minimize shadow difference. The Aspen Moviemap was an MIT-based project two decades ago. I was on the original team and continued making moviemaps professionally.

In a word, the trick to making effective moviemaps is seamlessness. Great care must be taken to insure that the film footage of moving along paths, and particularly, cutting from a path sequence to a turn sequence and back, is as visually matched as possible. Driving down the exact center of the streets and using gyro stabilized camera platforms help, but perfect “match-cuts” are never perfect.

Consider the anomaly that results from passing someone walking down the street during filming a moviemap. Since the control of speed and direction is made by changing the playback speed of the storage medium (e.g., laserdiscs), the real time nature of the walking person is lost. If the participant decides to “travel” more slowly, the person will appear to walk more slowly. If the participant decides to travel backward, the person will appear to walk backward. One solution is to make sure nothing moves during filming. The ideal solution is to digitally isolate transient objects from the imagery, a non-trivial and state-of-the-art problem.

Another time anomaly is sun and shadow. If a particular path sequence was filmed at 11 am one day and a corresponding turn sequence was filmed at noon, the shift of the sun and shadows will be apparent. Even a few minutes makes a difference. Cloudy days help, but less than one might believe.

It’s important to provide enough visual seamlessness to maintain overall spatial continuity, but from there, things can be stretched. For example, the Golden Gate Flyover is an aerial moviemap I directed in 1987, on exhibit at the Exploratorium. We used a gyro-stabilized helicopter camera and carefully filmed along a ten by ten-mile grid, at one-mile intervals, from 1,000 feet above sea level, always centered on the Golden Gate Bridge. Since we could fly at a precise ground speed, the camera filmed at a slow but constant frame rate equivalent to one frame every 30 feet. The interface was simply a trackball, and moving it allowed participants to “travel” over the Bay Area at speeds topping one mile per second. The result was a “hyper-real” experience, impossible in the world of first-hand experiences, unless you’re a superhero.
BE NOW HERE

Another upside of anomalous time, in theory, is that it allows us to experience more than one slice of time simultaneously. Consider, for example, a Breugel painting with dozens of people all in the same scene. Chances are slim that Breugel looked out his window one day and actually witnessed a hundred children playing in the street. More likely, his subjects appeared over time (or in his imagination) and Breugel used a single canvas to place them all together. A similar phenomenon was incorporated in my 1995 immersive installation called *Be Now Here*.

*Be Now Here* is a stereo-panoramic installation of public plazas in beautiful but dicey areas, specifically, UNESCO-designated World Heritage Sites In Danger. Like *Displacements*, a slowly rotating camera was used for filming, but with two cameras side-by-side for stereoscopic 3D. Unlike *Displacements*, rather than rotating the projector, *Be Now Here* rotates the audience, who stand on a 16-foot-diameter floor rotating in sync with the panning scene. The effect is similar to the “moving train illusion” we’ve all experienced when the train next to ours pulls out of the station and we think our train is moving.

For each of the four endangered locations, five scenes were filmed from exactly the same spot, where the tripod and camera system didn’t move a millimeter. The result was perfect match-cuts from one time of day to another, with only transient objects and light changing. A simple input pedestal located in the
center of the floor allowed participants to change location and time of day. Participant wore inexpensive polarized 3D glasses. Four-channel location sound added to the ambient feeling of “being” in these four endangered places.

Changing times of day in Be Now Here was magic. Like conventional montage, the world changes in the blink of an eye. But here, only time changes, while space stays exactly as it was. If the cameras had moved even a few inches during production, the magic would have been lost; the perfect registration of the buildings, trees, and mountains became the visual foundation on which the time anomalies comfortably rest.

Several years later, the Be Now Here footage was used for a space-time experiment, whereby three projectors were placed side by side to make a 180-degree composite image. Since the cameras rotated once per minute, offsetting the same sequence by 10 seconds resulted in a 60-degree shift, and thus a 180-degree image can be made with the same footage offset by 10 and by 20 seconds. If the footage contained little motion, the triptych projection appeared credible. With prominent motion (such as a camel caravan in Timbuktu), the projection appeared broken due to the repeated action every 10 seconds on all three screens. But with lots of non-prominent motion (such as a crowd scene in Jerusalem), the repetition appeared unnoticeable.

Slightly more daring, it was possible to make a triptych of the same place but of three different times of day, as shown here in Timbuktu and Dubrovnik. The sun, sky and people dramatically change. But even with such anomalies, the "placeness" apparently remains.

Anomalous Interaction
KARLSRUHE MOVIEMAP
The hardest part for many artists making interactive work for the first time is the realization that the audience matters and that their behavior must be taken into account. The extreme traditional view is that artists (unlike designers) work from an internal drive, independent of any audience. Think Michelangelo or Van Gogh. But the rules change when an interactive artwork “asks” its audience to participate.

In 1989 I had the opportunity to make an immersive moviemap installation. Unlike past moviemaps, which were viewed on a small screen, the Karlsruhe Moviemap was filmed with a wide-angle lens and projected onto a large screen. The moviemap, based on Karlsruhe’s famous tram system, allowed participants to control speed and to choose which way to go at each track intersection. A tramcar was used for filming—the camera was triggered by the tram’s
odometer—and the tracks assured unrivalled registration and stability of the footage.

A kinesthetic input system was built for the installation. Since the immersive image would create a visceral experience, why not get the whole body into the act? The input system was designed around a raised floor, with three illuminated foot switches in front to choose left, center, or right directions, and a broomstick-length speed lever that pivoted forward and backward. Participants held the lever to control speed and used their feet to control direction.

Bad idea. I watched in amazement and embarrassment during two public exhibitions, as participants mastered the speed control but stumbled around the floor looking for the foot switches. It turned out that, precisely because of the hypnotic, immersive quality of the screen, the last thing people wanted to do was to look down. By the third show, the raised floor was replaced with a modest but easy-to-use pedestal with hand controls.

**SEE BANFF KINETOSCOPE**

Our senses work together to form a single integrated experience. Even with some anomalies, a little bit of parallel support goes a long way. Using a variety of sensory modalities was explored in a project called *See Banff*.

*See Banff* was a stereoscopic moviemap made in 1993. It was a simple moviemap—single paths only, no turns—of scenes from the Banff region of the Canadian Rocky Mountains. A portable camera cart was built from a 3-wheeled “baby jogger” on which a stereoscopic pair of stop-frame cameras were mounted, triggered by one of the cart’s wheels. Based both on the concept of parodying tourism and on the technical requirements, the system was packaged in a hundred-year old style kinetoscope cabinet. It included a lever for selecting scenes, special 3D optics hidden in the eye hood, and a crank with which the participant could “travel” back and forth along the pre-recorded paths. It’s the crank that became the center of anomalous attention.

Since the moviemap sequences were all of finite length, the question arose of what to do with the crank when the scenes came to an end. One solution was for the image to simply go black, but this was unsatisfying. A better solution, it seemed, was for the crank to automatically freeze. A force-feedback brake was attached to the crank. When the first or last image of a sequence was viewed, the brake would switch on and the crank would lock up.

The effect was so effective that when the force-feedback was disengaged, something felt wrong. Obviously, a mental model of film mechanically transported through the device, with a beginning and end, was strong, and it was amplified
when the eye and hand received consistent signals.

But there was a small problem. The force-feedback brake was only so strong and could be over-ridden. An engineer colleague, Bob Alkire, had a curious suggestion: he said add an audio "pop" in sync with the brake engaging. Easy enough, so we did. The wooden cabinet was resonant, so the pop could be felt as well as heard. Magic! The result, based purely on adding an additional parallel sense, was that people actually thought we installed a more powerful brake.

But the problem didn't entirely disappear. Anyone (big males in particular) could still force the crank to move when the brake was engaged. An even more curious solution was proposed by Joe Ansel, former exhibit director for San Francisco's Exploratorium. He noticed that a mechanical bearing coupled the wooden handle to the crankshaft, allowing participants to grip the handle while turning it. He said "take it out." Everyone was puzzled. Joe explained that without the freely rotating bearing, participants would have to hold the handle lightly, to let it rotate under their grip. Joe's solution worked like a charm. The "light-handedness" made the brake feel even stronger. And the cost was, well, a negative number.

So in the end, the least anomalous interface required a force-feedback brake added, and an audio "pop" added, and a mechanical bearing subtracted. Who knew?

Violation or Metaphor?

Sensory anomalies are funny things. I once slowed down the real-time motion of a film in an art installation to half speed, resulting in everyone appearing to move in slow motion. I had my reasons, but a colleague, a well-respected engineer, was shocked, as if I had violating something.

I had.

Metaphor to some is violation to others. "Faithful representation" is a noble engineering goal, but things aren't quite as clear in art and design. To confuse—or clarify—things further, good metaphor can often be a form of shorthand. If we share similar cultures, backgrounds or personal experiences, metaphor is a form of abstraction of compression. So in the end, the degree of faithfulness and the degree of violation depend on what we want to say. Sensory anomalies sit on both sides of this fence.