THE FUTURE OF

PROJECTION MAPPING

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Originally called “Spatial Augmented Reality,” the practice is a means to create convincing illusions in physical space—a method of augmenting the physical with the digital without requiring intermediary devices like glasses, tablets, or headsets.

The first known public display of projection mapping premiered in the Haunted Mansion attraction at Disneyland in 1969. Two show effects on the ride—the “Madame Leota” disembodied head in the séance scene and the quintet of singing busts in the graveyard scene—were accomplished by projecting 16 mm film of performers onto sculpted busts of their faces. Despite the technology’s early origins in the themed entertainment industry, however, it was another four decades before projection mapping came into wide use in theme parks.

Through the 1980s and 1990s, the practice was largely relegated to experimental art installations and academia, but by the mid-to-late-2000s, large-scale projection mapping on the facades of buildings began to gain popularity across Europe. Experiences like 555 Kubik in Germany in 2009 and the annual Fête des Lumières in Lyon, France integrated projection mapping into the tradition of son et lumière or “sound and light” shows, which had been playing on historical European structures since the 1950s.

Growing interest in projection mapping coalesced in 2010, when it took off as a “guerilla marketing” tool. Over the course of that year, brands including BMW, Nokia, Samsung, Volkswagen, Toyota, Youtube, Ralph Lauren, H&M, and HP all implemented large-scale projection mapping experiences to promote new products and drive viral engagement. While still appearing predominantly in Europe, experiences like Youtube Play’s event at the Guggenheim and Ralph Lauren’s “4D digital experience,” which premiered at both the brand’s flagship in London and their new store on Madison Avenue in New York, introduced large-scale projection mapping to an American audience.

With its popularity rising around the world, projection mapping returned to its theme park birthplace. Though parks like Disneyland had featured a nightly fireworks spectacular since the 1950s, projection mapping wasn’t added to the mix until January 2011, when The Magic, the Memories, and You opened simultaneously in Disneyland and Disney’s Magic Kingdom parks. Since then, nighttime projection shows have spread to major theme parks all across the world.

Today, projection-mapped shows are a mainstay of themed entertainment. Whether combined with physical effects like pyrotechnics, lights, or water fountains to create large-scale spectaculars, or integrated as small-scale effects to enhance attractions and live shows, projection mapping has become an essential tool in creating delightful, magical, and surprising immersive experiences and will continue to amaze audiences for years to come.
Creating a successful projection-mapped experience requires a balance of out-of-the-box creativity and a technical understanding of the medium's strengths and limitations.

Complicating matters is the fact that, as a heavily technological art, projection mapping’s capabilities are constantly changing. With projectors, software, and computer hardware continually improving, projection mapping can accomplish even more convincing effects in even less ideal environments with each passing year. At the same time, however, there is a core set of guiding principles that can ensure successful projection mapping no matter the scale of the project.

Projection mapping is a multidisciplinary practice that draws on techniques from a number of “traditional” media disciplines, including cinema, theater, and animation. Depending on the surface taking projection and the experience’s goals, a designer may choose to favor techniques from one field over another, drawing more on cinematic techniques on a flatter surface, for example, or emphasizing theatrical staging in a large-scale, large audience spectacular. Regardless of what combination of techniques is ultimately used, it is important to remember that though projection mapping draws elements from all of these disciplines, it is also distinct from each field. Techniques used to convey a certain meaning or effect in one medium may not convey the same meaning when applied to projection mapping.
Take film, for instance. Typical cinematic language includes the narrative use of shots, editorial pacing, camera moves, atmospherics, depth of field, and lensing. Drawing on over a century of audience experience interpreting the shared language of cinema, these techniques can be useful tools in conveying story or emotion in a projection mapped experience, but they also may not function as expected when overlaid on an object like a building. Shallow depth of field and other lensing techniques used to direct focus in film, for example, often do not read well on mapped objects, only serving to reveal the structure’s underlying architecture.

As projection mapping shows take place in a shared space with a fixed audience viewpoint, the medium also shares much in common with the language of theater. Features of the theatrical medium include the importance of staging and scale, considerations for real-space layout, and the shared audience experience of viewing a show in person, together. However, unlike live theater, which is limited by the laws of physics, projection mapping also allows for the impossibilities of illustration and animation.

Projection mapping’s technological nature can encourage the tech, rather than the experience, to lead the design—shoehorning in “technology for technology’s sake.” But, like all art, the best projection mapped experiences begin with an idea, emotion, or story. Technology should be chosen in service of the experience’s goals, rather than the other way around. In fact, the most successful projection mapped experiences are those in which the technology is all but invisible, leaving the audience with only a sense of awe at the seemingly impossible transformations occurring right before their eyes.
The best projection mapped experiences understand where projection mapping excels—and when it falls apart.

Because projection mapping involves projecting a flat, two-dimensional image onto a physical, three-dimensional object, it relies on forced perspective to give projected content the illusion of continuity and depth. While this forced perspective will perfectly match the object’s perspective from a single ideal viewing angle, called the “king seat,” the further off from this angle a spectator gets, the more the illusion will begin to warp and fall apart. For this reason, projection mapping is among the most effective augmented reality experiences for a crowd, as long as the crowd’s viewing angle of the mapped content is relatively restricted. As a general rule, objects that can viewed from drastically different angles are not well suited for projection mapping, though this constraint can be somewhat mitigated by the use of multiple king seats (on multiple sides of a building, for instance), with blended seams where the differing perspectives meet or overlap.

In addition to the viewing angle limitations caused by mapping a 2D perspective onto a 3D object, the use of irregular physical objects as projection surfaces introduces a number of further unique challenges. Unlike traditional flat or domed projection surfaces, complex physical objects like buildings can vary widely in color, specularity, and form. A darkly-colored roof, bank of windows, or extruded piece architecture, for example, can interfere with projected colors.
The interaction of projected light with the complexities of a real-world surface is both fundamental to projection mapping’s illusion and also one of its greatest potential pitfalls. When the limitations and features of the surface are taken into account, subtle changes and even dramatic transformations across the existing architecture are extremely convincing. This is where the “magic” of projection mapping lies. Confronted with media carefully conformed to a physical surface, the human eye is unable to distinguish a digital feature from a physical one. However, if the irregularities of the physical surface are ignored, content will appear broken up, muddled, and confusing.

**Crucially, the most effective, most “magical” projection mapping effects are rooted in the realities of the underlying projection surface.**

Mitigating the challenges of a real-world surface requires integrating its form into the experience’s design from the very beginning, while simultaneously creating content in such a way as to be adaptable to unexpected discoveries onsite. Key show moments should be staged with consideration for their legibility on the surface, and potential “problem” areas—like untreated windows or heavily textured, dark, or highly reflective materials—should host only textural content that is not essential to understanding the experience. At the same, even the most fastidiously designed content still benefits from adjustments on the actual projection surface. As the bulk of most complex projection-mapped shows is completed in-studio, flexibly built content allows calibration once onsite, with additional color correction, scale, and placement adjustments further improving content legibility and efficacy.

Environment is also an important consideration when projection mapping. While films and theatrical productions are typically viewed in darkened theaters designed to focus audience attention, large-scale projection mapping experiences often take place in environments that offer limited or no control over the surrounding area. Ambient light from surrounding buildings, sound intrusion, and other visual occlusions can provide additional challenges to creating a fully immersive experience.

As projection mapping is a light-based technology, ambient light interference especially can prove a challenge. In outdoor projection mapped environments, true blacks are often impossible to achieve, as the “darkest dark” possible on a surface will be limited by the ambient light levels of the space.

Another unique feature of projection mapping is its scale. Projection mapping can be applied to objects ranging from small props to the facades of multiple multi-story buildings. Large-scale projection mapping requires a number of special considerations, including attention to speed of motion and techniques to guide the audience’s eye over such vast distances through the experience. Smaller scale projection mapping that allows the audience to stand closer to the mapped object requires attention to projector placement and more minute details like pixel stretching.

Projection mapping is a versatile and unique medium that, at its most impactful, can create mind-blowing effects and experiences. By incorporating the realities of the projected surface into the design from the start, taking into account viewing angles, scale and the surrounding environment, and reacting flexibly to unexpected challenges and felicitous discoveries on the projection surface, designers can create experiences that are all but indistinguishable from magic.
The Future of Projection Mapping

What’s Coming Next?

Projection mapping capabilities will only continue to evolve as technology improves. While unexpected developments will almost certainly push the field in new and exciting directions, several anticipated advances already promise a host of new possibilities.

Next-Generation Projectors

It is no coincidence that projection mapping only began to gain momentum after LCD and DLP projectors became commercially available in the 1990s. Previous projectors were simply too dim or too unmanageably large to project from the odd angles and in the ambiently-lit conditions required for most projection-mapped experiences. Today, laser projectors have further improved both luminosity and resolution, making mapped experiences brighter and more convincing.

As projector technology continues to advance, projection mapping will become viable in even more use cases. Smaller, lighter-weight projectors and ultra-short throw lenses will allow designers to place projectors in a wider variety of locations and closer and closer to the surface receiving projection. Increases in resolution and better technology for projector heat dissipation will make projected images brighter and crisper, even as more affordable projector models will increase the technology’s feasibility for smaller and lower-budget experiences.
While “interactive” projection content has been around for decades, the majority of projection mapped experiences involve linear, pre-rendered media. With improvements in game engine technology, projection mapping is poised to incorporate more and more realtime rendered media, including dynamic perspective shifting and audience-driven content.

As noted previously, projection mapping’s viewing angle has traditionally been fixed, with the content looking best from the king seat and becoming increasingly warped the further off from this angle a spectator stands. Using a game engine to render content, however, it is now possible to track a spectator’s position relative to the mapped object and dynamically change the perspective to appropriately align as the viewer moves. This dynamic perspective shifting resolves one of projection mapping’s primary limitations—that of a fixed audience viewpoint—though it does, in turn, reduce the possible size of an audience to only those able to track with the moving viewpoint (a single person, or group of people moving together, as in a ride vehicle).

In addition to incremental improvements in projection, software, and previsualization, the next major leap in immersive media experiences involves a complete reinvention of the concept of a “surface” or “screen” itself—the advent of true holographic displays. Developments in lenticular, autostereoscopic, super multiview, and especially light field display technologies have put truly dimensional holographic experiences finally in reach. While projection mapping’s apparent dimensionality results from the interaction of 2D media with a 3D object, with light field displays, audiences will be able to see truly 3D media projected into empty air, without the need of glasses or a headset. These real holographs will be fully dimensional, without the constraints of traditional projection mapping’s fixed viewpoint or dynamically-perspective-shifted projection mapping’s limited audience, and will create an entirely new branch of immersive media content.

Companies like Light Field Lab are developing true hologram technology that will offer even more avenues for dimensional media content.
From the first time people gathered to tell stories around a fire, light has played a central role in humanity’s drive to entertain.

Shadow plays, magic lanterns, cinema, and now projection mapping have all built upon our fundamental fascination with light and color to enthral audiences with seemingly impossible effects and immerse people in new worlds.

As technology continues to develop and improve, we will discover even more methods to harness light as both an art form and a tool. And just as our ancestors once huddled in rapt attention around a fire or gasped at the approach of a train in one of the world’s first films, we will continue to gather in wonder to see light made magic.
BIBLIOGRAPHY


