Historical Perspective

Holograms: The Story of a Word and Its Cultural Uses

Sean F. Johnston[1]

ABSTRACT

Holograms reached popular consciousness during the 1960s and have since left audiences alternately fascinated, bemused or inspired. Their impact was conditioned by earlier cultural associations and successive reimaginings by wider publics. Attaining peak public visibility during the 1980s, holograms have been found more in our pockets (as identity documents) and in our minds (as video-gaming fantasies and "faux hologram" performers) than in front of our eyes. The most enduring, popular interpretations of the word "hologram" evoke the traditional allure of magic and galvanize hopeful technological dreams. This article explores the mutating cultural uses of the term "hologram" as markers of magic, modernity and optimism.

The hologram is an unusual invention: an innocuous optical device that carries within it the ability to generate three-dimensional imagery. But since its conception after World War II, the form, meaning and symbolic associations of this visual technology have been repeatedly recast and extended. The hologram made its public debut in the 1960s as an awe-inspiring, three-dimensional imaging medium that was reinterpreted by new adopters. Engineers, artists, hippies and hobbyists played with---and dreamed about---holograms.

For growing audiences, this perplexing phenomenon was portrayed as the essence of modernity. But just as compellingly, the hologram captured popular imagination as technological sorcery. It evoked the ancient attractions of magic and the mysterious. Simultaneously representing the future and the past, the hologram became a symbol of latent potential. For the subsequent generation, what could be called "faux holograms" became associated with video games, entertainment spectacles and forthcoming device displays. New viewers, in fresh settings, invested the term "hologram" with expanded meanings, having little connection to the real-world technology.

This article examines cultural engagement with holograms, how this connection was conditioned by prior experiences and how understandings and usage have evolved over more than half a century to shape our notional futures.

Channeling Magic

They say "You won't believe it after you've seen it." Holography is a new extension of photographic methods made possible by the use of lasers. . . . One can move his head from side to side (or up and down) and actually see behind objects in the foreground. If you are interested in the vanguard of science this will be *the* program for you [1].

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[1] Sean Johnston, Professor of Science, Technology and Society, University of Glasgow, Rutherford-McCowan Bldg, Bankend Road, Dumfries DG1 4ZL. Email: <Sean.Johnston@glasgow.ac.uk>.

For the first 20 years after their creation, holograms weren't seen much by the public. Invented at the British Thomson-Houston Company in 1947 by Hungarian engineer Dennis Gabor as a means of improving electron microscopes, holograms went underground until the early 1960s. At Willow Run Labs, a postwar contract facility at the University of Michigan, engineers developing the concept for military image processing found that, with newly available lasers, holograms could act as windows that generated phenomenally realistic three-dimensional images. Working concurrently, in even greater isolation, Yuri Denisyuk at the Vavilov Optical Institute in Leningrad independently invented a distinct variant that behaved like a magic mirror to reveal three-dimensional objects behind it. Many of the engineers' peers and successive researchers inhabited similarly covert environments around the world [2].

Once revealed, however, the miracle of holograms proved difficult to express to a wider public. Through the rest of the decade, holograms were witnessed mainly by engineers and reporters at conferences or private demonstrations. As a result, these interpreters were important in framing the nature of the new invention for larger audiences. And the easiest fit for the interpretation of a hologram was the ancient lure of magic.

Holograms had baffling qualities that evoked the novelty of childhood experiences and the appeal of sorcery. Emmett Leith, the principal contributor at Willow Run, framed their miraculous results as a mystifying conjuring trick:

> It was most fascinating, because here you had a piece of film that had nothing but garbage on it . . . and then you looked downstream where they came to a focus, and there you saw a real, nice, sharp image, and there was nothing producing it---there was an image but no optical elements---kind of like a grin without a cat by Lewis Carroll's analogy [3].

Even when that enchantment was more drily reported to peers in their first conference paper, the American Institute of Physics repackaged their technique with an evocative label, "lensless photography," which shaped public understanding over the next two years [4].

Newspaper stories struggled to categorize this new scientific black art, in which a "camera without a lens" could clarify a smudged or blurry negative, or even magnify hidden details [5]. Like a magic show, the disorientation, surprise and charm of viewing holograms reduced even experts to a state of unsophisticated wonder:

> "It is the most startling thing I have seen," said a nuclear scientist from the Argonne National laboratory. A navy captain said, "It's fantastic. I don't see how it can be done." Many of those who viewed the picture asked to touch the photographic plate to assure themselves that it was indeed flat [6].

> The General in Washington thought he saw a chessboard. He reached out to touch one of the pieces. But the board was not really there. He was seeing a three-dimensional projection of the chessboard produced by the astonishing new technique of "holography" [7].

Experience of apparent dematerialization were accompanied by other magical qualities. Holograms were liminal objects: featureless panes of glass which, when lit by a laser, transformed into a window onto another world. These modern crystal balls remained clouded for those without a magician's skills.

The first newspaper article to describe the hologram plate recounted it as "a transparency that looks to the eye like a buttermilk sky" [8].

An even more intriguing quality of holograms was communicated almost exclusively secondhand--- becoming, in fact, a contemporary legend that was applied indiscriminately to all holograms. It expressed not a conjurer's trick but a deeper metaphysical riddle: A small part of a hologram is able to reproduce the whole scene. The earliest reports of holograms recounted this extraordinary characteristic as the strongest confirmation of magic:

> The whole or any part of it contains the entire picture. Tear it up and any fragment of it will reveal the total picture under laser light [9].

But for many observers, the most compelling attraction was the viewer's ability to bob and weave, to *interact with* a hologram scene. This property of parallax was mystifying for audiences familiar with Victorian stereoscopes and 1950s 3D motion pictures. As reporters enthused,

> The scene in the Michigan lab was *real* 3D---without special glasses. By lifting my head, I could look down on a toy tank's turret; when I stooped, I was level with the treads. I could move my head and look around things. And the closer I got to the window, the wider my field of view became [10].

The realism was strengthened by a subtler, but equally novel, property: exactly like a real scene, holograms required viewers' eyes to focus at different depths as they examined the scene [11].

Such properties mapped onto a conjuring act. Holograms generated visual confusion, reproducing stage levitation routines, séances and vanishing tricks---seemingly hanging in space, being revealed as ethereal when sought with a hand or disappearing instantly when the laser was turned off. The stage magicians of vaudeville and contemporary variety television had trained generations to appreciate these tricks as entertainment to be enjoyed but not analyzed [12].

Ironically, the first mass exposure to what many viewers thought were holograms opened at Disneyland in 1969. Based merely on reflections from glass plates, the *Haunted Mansion* attraction yielded ghostly floating images---consolidating the connection between spectral magic and modern science for thousands of visitors [13]. To the chagrin of hologram creators, the trickery, a Victorian stage illusion known as "Pepper's Ghost," was to become the most common technology to masquerade as holograms over the following decades [14].

Other audiences stretched the concept of the hologram further. Holograms were appropriated by counterculture artisans during the early 1970s, attracted by their transcendent implications and ability to generate paradoxical and entrancing imagery. The tropes of the magic show gave way to [associations with] mysticism and higher consciousness. As *Rolling Stone* magazine put it:

> The hologram is as likely as anything technological to push your subliminal awe and wonder button and leave an ancient message flashing somewhere below the surface of consciousness: Here we have some Powerful Magic [15].

Extending Modernity

Holograms also tapped into cultural understandings of the future and its reliance on the applications of modern science. They exemplified the hallmarks of modernity: the attraction of inventive novelty and faith in the ever-advancing products of technology.

Lasers, from which holograms sprang, provided their own cachet of technological magic: Their beams remained pencil-thin over incredible distances and, demonstrated for public consumption, could perform spectacular tricks like transmitting telephone conversations, selectively bursting colored balloons or piercing razor blades [16]. In *Goldfinger* (1964), James Bond was threatened by a fictional high-powered laser beam, linking scientific advances, black ops and adventure [17]. Indeed, the first newspaper report on the Michigan holograms was subtitled "Death Ray in Laboratory" [18]. The quality of laser light itself was enchanting; so-called "laser speckle" made surfaces shimmer with scintillating sparkles of light that moved along with the viewer.

Lasers and holograms were the products of a new kind of scientific laboratory, no longer inhabited by the lone mad scientists, electrical machines and jumping sparks common in 1930s films [19]. Media representations of mid-century labs transmuted lasers and holograms into new stereotypical forms that combined the dedication and secrecy of an alchemist with the powers of a magician but were devoted to inventing the future.

For the most technology-savvy observers, holograms could be linked to earlier inventions in a way that suggested the inexorable progress of the modern world and the benefits to follow. This faith demanded that holograms be fit into a conceptual schema. But---as suggested by the fleeting currency of the "lensless photography" label---holograms resisted familiarization. Waves of science writers strained to categorize and explain [the technology], falling back on a series of metaphors that highlighted the unintuitive, mysterious properties of holograms. This tension between rational understanding and magical properties has been a persistent attribute of holograms.

A subset of artists who worked with holograms also submitted to the modernist spell, suggesting that---like fine-art photographs, graphic arts and creative video---holograms would inevitably become embedded in mass culture. Art holograms were first exhibited in 1968 and subsequently found increasing visibility in large public exhibitions. This generated exponentially bigger audiences through the early 1980s, reaching hundreds of thousands of viewers at the major shows around the world [20].

These exhibitions expanded popular understandings. For people seeing their first holograms, exhibition promoters increasingly selected the most spectacular imagery, replicating an approach adopted by earlier visual technologies. Exhibition holograms favored visual novelty and shock, such as images appearing in front of---or even *through*---the hologram plate, simple forms of animation and bright, spectral colors [21]. Holographic artists consequently found their art diluted by practitioners and works that focused on technological spectacle. As early as the mid-1970s, postmodernist critics disparaged the medium as an unimaginative form of technological propaganda [22].

For technologists and entrepreneurs, modernist faith nevertheless remained compelling. Understanding how holograms were like earlier technologies would allow them to be marketed with confidence, reassuring investors, developers and consumers. So, besides the analogy of holograms as improved photographs, further associations were proffered [23].

Early descriptions conceptualized holograms as upgraded video technology for remote viewing:

The train wasn't really there at all. But if you stood in exactly the right place and looked into a piece of equipment you would have seen it, real as life [24].

> At the NEC [National Electronics Conference, Chicago, October 1965]**,** long lines of scientists saw a chessboard with five men, a toy railroad scene and a model of an army tank. The objects were really back at the university's laboratory in Ann Arbor [25].

The disconcerting spectacle was thereby tamed: The baffling science could be reimagined as akin to television, or even more conventionally, as trickery with mirrors. A more stretching metaphor conflated the ideas of freezing light with what was later dubbed, in the age of video recorders, time shifting:

> Basic to holography is the idea of freezing light interference patterns in a moment of travel; then, at any convenient time, freeing them to continue their journey. As they are released from the hologram, the light waves recreate the scene just as it existed, although the objects have been removed [26].

This concept struck familiar cultural chords; for 60 years, the public had been buying sound recordings to play back musical entertainment at home. For the past 15 years, tape recorders had personalized this power to capture and release sound, and within the same decade, stereophonic technologies were beginning to recreate life-like soundscapes via long-play recordings and FM radio.

Holograms were particularly well placed to exemplify progress. Illustrating the power of the new postwar style of muscled scientific research, holograms were a spectacular example of the products of rational science and technological advances. By the late 1960s, consumers were being tempted to imagine the near-term promise of holograms. While opportunities to directly experience holograms remained limited, accounts of them multiplied in the popular media. Mass-media forecasts about the progress of holograms---unconstrained by reality---began to suffuse modern culture.

Thus early holograms captivated public imagination and spawned enduring popular interest. Cultural appropriations multiplied, democratizing holograms and multiplying their meanings. Hinting at both magicians' tricks and reassuringly familiar technologies, growing audiences suggested a cultural place--- and a consumer future---for holograms.

Canning the Uncanny

As opportunities to witness holograms grew, popular understanding evolved to fit a narrative of consumer benefits. The century-old appeal of three-dimensional imagery had been satisfied successively by stereoscopes, 3D movies and children's anaglyphic (two-color stereoscopic) comic books. Prewar audiences had anticipated that television would rapidly extend to the third dimension [27], and their postwar counterparts were seduced by similar extrapolations [28].

The first companies to seek investors for holograms cynically seeded dreams of their potential. The most brazen of the promoters, Kip Siegel of the Conductron Corporation in Ann Arbor, MI, argued for a headlong leap toward the future:

> We are doing major work in 3-dimensional television and towards 3-dimensional home movies. . . . I am hoping that by the year 1976 that the United States will have, as far as new

products are concerned, only three-dimensional television and three-dimensional movies on the market. . . . I don't think people will buy things that are antiquated [29].

Such imagined futures conjured up ancillary technological magic: pulsed lasers to capture holographic moving images of outdoor scenes and living people. The task would demand intense pulsed lasers---impossibly powerful and dangerously bright, in fact. As Gary Cochran, the manager responsible for the work, recalled, Conductron's working culture was "an imaginary Disneyworld of scientists" [30].

Despite the company recognizing the impossibility of these claims, Siegel's predictions carried the ring of insider authority. Like falling dominoes, prediction triggered prediction in an unstoppable cascade. A *Life* magazine article, for example, suggested that within 15 years home viewers would enjoy "an 8-foot John Wayne in 3-D . . . and even walk around him" [31]. The combination of commercial hype and disorienting magic made the wider public easy prey to the first corporations that were exploiting the technology, most of which had gained their foothold in the field via research and development contracts with the American military, NASA and the National Science Foundation.

Focusing Dreams

While public interest in holograms was rising during the late 1970s and early 1980s via exhibitions and consumer products, a second and distinctive perception began to extend the meaning of the word. Its source was science fiction, whose initial notions were inherited from optimistic technologists' forecasts of the previous decade. But imagined holograms also evoked other associations: older technologies, contemporary folklore, corporate rumors and---just as significantly---myth and magic.

As early as 1968, a John Brunner novel described a "holocam" for recording three-dimensional images, "lit by LazeeLaser monochrome lamps" [32]. The first science fiction story to focus its plot on holograms appeared four years later, casting them as a form of three-dimensional, interactive television. The imagined technology was a recognizable echo of the predictions disseminated by the Conductron Corporation six years earlier: "to actually participate, to star in your own favorite holovision shows, right in the comfort and convenience of your own home" [33].

First introduced to fiction by Larry Niven, the abbreviation *holo* and the prefix *holo-* were rapidly consolidated in readers' minds [34]. Other science fiction writers picked up on and expanded the tropes as nuanced elements of their own imagined futures. For John Varley, "holomist" was a form of advertising that hounded prospective customers, playing "breath-catching tricks with perspective" [35]. For Philip K. Dick, a "holo-cube" was a computer-generated immersive environment that could be called up, entered and collapsed at will [36]. Arthur C. Clark conceived a "holopad," a medical monitor with a three-dimensional display [37].

Set in the indefinite future, William Gibson's meticulously detailed fictional worlds invested holograms with qualities that have become familiar in subsequent science fiction stories. Inventing holographic novelties of the future---and just as rapidly jumping beyond them---he has imagined "Disney technicians . . . employed to weave animated holograms of Egyptian hieroglyphs into the fabric of your jeans"; "peeling chrome over plastic, blurry holograms that gave you a headache if you tried to make them out"; and, "a defective hologram in the window, METRO HOLOGRAFIX, over a display of dead flies wearing fur coats of gray dust" [38].

Gibson's cyberpunk world---a run-down and cynically peopled urban environment that he dubbed "the sprawl"---provided both a contemporary judgment and futuristic prediction for holograms. He predicted that their powers to entertain the public would wither:

> Holography went too, and the block-wide Fuller domes that had been the holo temples of Parker's childhood became multilevel supermarkets, or housed dusty amusement arcades where you still might find the old consoles [39].

For more optimistic audiences, science fiction portrayed holograms as elements of a visually exciting technological world. Contemporary cinema, television and video games illustrated what the fiction writers had described. Their visual properties were envisioned compellingly with the release of *Star Wars* (1977) [40]. The cinematic depiction of a hologram, combining a cone of light from R2-D2's projector, a juddering blue-cast image evocative of a badly tuned black-and-white television set and---most influential of all---the beaming of this specter into empty space, made the vision memorable for film audiences and created a link between holograms and electronic media for the viewing public. The *Star Wars* sequels visualized further uses for holograms as static displays and improved image playback devices. Like the examples in Gibson's imagined worlds, cinematic holograms were conventionally stuttering, run-down and imperfect. Ironically, this flawed visual image was conducive to the public engagement with later "faux hologram" entertainers, such as those introduced by CNN's election-night reporter in 2008 [41] and that of Tupac at Coachella in 2012 [42].

Star Wars and its sequels were followed by a wave of holographic fantasy characters. The British comedy television series *Red Dwarf* (1988--1999), set on board a spaceship in the distant future, extended the attributes of fictional holograms to mythical, animated creatures. One of the characters in the series, Rimmer, is a hologram calculated in real time by the spaceship's computer. His three-dimensional image, melded seamlessly with an AI personality, evokes a comically updated version of Frankenstein's monster [43].

Similar illusions were part of the second *Star Trek* television series, *The Next Generation* (1987--1994), with its depictions of a "holodeck," in which an interactive environment was calculated and displayed by a computer [44]. In *Deep Space Nine* (1993--1999), the technology became commercialized, with "holosuites" rented out for private use [45]. And in the subsequent *Voyager* series (1995--2001), these technologies were used to implement an Emergency Medical Hologram, or virtual doctor [46]. Such sentient computer programs embodied in a hologram became part of the ontology of subsequent *near*-future fiction, too. In an episode of the 2014 television series *Perception*, for example, the abilities of a modern-day AI and hologram researcher were embodied in a holographic double; when the professor was murdered, his doppelganger helped to solve the crime [47].

For a younger generation, the animated television series *Jem and the Holograms* (1985--1988) imagined holograms as a technology of self-empowerment. The plot centered on a holographic computer and projection device, Synergy, that had characteristics akin to *Red Dwarf*'s protagonist and *Star Trek*'s holodeck. With the holographic computer, the principal character, Jem, was able to transform her local environment and cloak her identity. The result was alternately an "entertainment synthesizer" and a shape-shifting device for adventures [48]. It is notable that the term "shape shifting," which sprouted in popular fiction from the 1970s, is an ancient motif traditionally linked to magic and sorcery. Thus fantasy holograms, like their real-world counterparts, were enriched by folklore and conjuring.

Beginning in the 1990s, video games began to portray such visions of modern magic to increasingly wider audiences. Some games extended real-world engineering claims, while others rehearsed the metaphors that had been introduced in science fiction cinema and television. But---as with other media representations---video games also added additional attributes to holograms. The most influential notion, depicted in video games dedicated to battlefield simulations, was of the hologram as a synthetic mirage. In *Command and Conquer: Red Alert 2* (2000), "mirage tanks" project holograms to masquerade as trees [49]. Similarly, in *Halo* (2000), holograms create decoys or cloak facilities [50]. Gameplay holograms mix and match properties promiscuously. In *Crysis 2* (2011), a "holographic decoy" is a weapon attachment that can spawn a replica soldier to attract gunfire [51]. In an even more dynamic role, *Duke Nukem 3D* (1996) includes a "HoloDuke" device, which projects a holographic mirage that can battle [52].

Flourishing subcultures of gamers could invest their simulated worlds with complex perspectives drawn from real life; however, less worldly fans increasingly confused the imaginable with the feasible, and even the inevitable. As for the earlier generation of gullible investors and consumers, these immersive fantasies---many of them drawing on the [allure] of magic and the mysterious---became so compelling that they escaped the gaming world to blur with reality. When multiplayer games allowed real-time cooperative gameplay, Internet discussion groups and other social media encouraged lengthier dialogue. Holograms and their enigmatic properties have been liberated by online fantasy.

Owing to the enculturation provided by video games and the wildfire mutation of online information, this compelling mixture of mystery and high technology has become a democratic art: Mass audiences play a role in actively constructing the cultural identity of holograms. A popular myth that the U.S. military is developing, or has even perfected, holographic "projections" to frighten or confuse the enemy have become an Internet meme, originating from a combination of institutional musings and video gaming [53]. Since the late 1990s, online forums have elaborated the tale into an advanced covert project aimed at deceiving foreign or domestic audiences ("Project Blue Beam," ostensibly under the aegis of either NASA, the Defense Advanced Research Project Agency [DARPA], or the United Nations). Holograms satisfy the distinct attractions of hidden science, magical portrayals and conspiracy theories. Thus optimism and credulity, in equal measure, have dogged the imagined holograms of the 21st century [54].

Experienced vicariously through news stories, online dialogues and video games, it is notable that most cultural exposure to holograms is typically second- or third-hand. Not coincidentally, the broader cultural meanings of the term have flourished in contexts devoted to entertainment: adventure movies, theme parks and gameplay. Mediated representations have swamped direct experience.

Consequently, the notion of the hologram has evolved over half a century to label impossibly diverse combinations of modern sorcery and technical wonder. While holographers may prefer to distinguish their products from "faux" or "misidentified" technologies, the current usage of the term "hologram" has irretrievably broadened to label any glasses-free imaging technology that can astonish, disorient and entertain.

Technology fertilizes dreams and aspirations, some of which are endemic in human cultures. For various audiences, the hologram has represented mythical magic, modernist dreams (or their decline), a forthcoming mass medium or the secretive tool of a militaristic state. In various guises, it has come to inhabit most of our imagined futures. Holograms did not merely create new aspirations; their special power has lain in channeling the expression and realization of long-familiar themes.

The greatest impact of holograms, consequently, has been in our minds. Holograms have had their most enduring influence as an expression of the magical and as a metaphor for the future. This expanded meaning has given the term "hologram" a cultural life beyond the reach of its creators.

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Biography

Sean Johnston is Professor of Science, Technology and Society at the University of Glasgow, with training in physics and in the history of science and technology.
His research explores how new technologies and social groups develop hand in hand. Current interests focus on the grassroots activities and influences of amateur scientists, crowd-sourcing and 'maker' communities.