KINEPHANOS

Reconstructing *WARRIOR*: Vectorbeams, Natural Magick & Business Intrigue

Thomas H. Rousse

Abstract

Warrior, a two-player fighting game released by Vectorbeam/Cinematronics in 1979, represents an early pinnacle of integration between analog and digital displays in the history of arcade gaming and a terminal point for vector monitor technology. This article examines the business intrigue around *Warrior*, its adaptation of the "Pepper's Ghost" optical illusion, its use of vectorbeam technology, and several attempts at the game's reincarnation.

Keywords

Arcade machine, Tim Skelly, Lawrence Rosenthal, Cinematronics, Vectorbeam, platform studies

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Figure 1 - Knight 2 in the upper left corner of the screen during attract mode. Screen capture of video taken by the author.

Introduction

"WARRIOR" is a two player vector generated video game designed to give the player realistic sword fighting action. The three dimensional effects brought about by the playfield and the high video resolution of the VECTORBEAM(TM) monitor are only part of this. The feeling of realism is also brought about by the energy hum in the audio circuit and the spectacular artwork by renowned fantasy artist Frank Brunner.

—*Warrior* Operation and Maintenance Manual (1979), p. 3

In the late summer of 1979, workers put the finishing touches on *Warrior* arcade cabinets at the Vectorbeam manufacturing plant in Union City, California. In the depths of Midwestern winter in Ann Arbor, MI, the last *Warrior* cabinet open to the public rumbled loudly in the basement of Pinball Pete's in January 2013, across from *Star Wars: Racer Arcade* (LucasArts, 2000) and right next to *Robotron: 2084* (Vid Kidz, 1982). Perhaps in the middle of the night, or even in the middle of a bout, the vector monitor responsible for drawing the two knights made of triangles on the half-silvered mirror's reflection of the vibrant hand-drawn background burns out. The blacklight still reflects the castle interior onto the mirror; the crotch-height speaker still roars when a curious passerby drops a token into the slot. Yet players can no longer direct the vector-drawn swordsmen to duel or push each other down infinite pits. Is this the moment, some thirty-four years after its release, that *Warrior* in its original form exits the realm of public space?

If there is another *Warrior*-in-the-wild rumbling on in a distant Laundromat or pizza parlor, it seems no word of it has reached the collectors and curators contacted for this article. Perhaps

Pinball Pete's *Warrior* will be repaired and returned to its place on the arcade floor, or another instance of the machine will be made available at a museum exhibit or vintage-themed arcade in the near future. In any case, *Warrior* as originally conceived is no longer readily accessible, even to those players willing to trek cross-country for the chance to play rare games. Collectors with deep pockets may need to wait months or years for an existing copy to enter the market.

In brief, this article attempts to trace the origins of *Warrior*, understand its place in popular culture during its thirty-six year history thus far, and trace the outlines of its peculiar reincarnations. Using *Warrior* as a focal point, this article is also an exploration of what information has been preserved about the early history of games as a mass medium, how perceptions of arcade games have changed for would-be historians, and how later developments in the medium of the videogame have biased later histories. I focus on three divergent points of interest in an attempt to triangulate the origins and of this rich artifact: a media archaeology of the optical illusion that gives *Warrior* its singular aesthetic, a platform study (Montfort & Bogost, 2009) of the vectorbeam technology underlying its digital aspects, and an attempt at parsing the business intrigue that surrounded the game's creation. In turn, this article examines issues as diverse as technological transfer from academia to industry, material limitations on design, obsolete technology, patent fights, and conflict between creators and management. I conclude by examining three moments of *Warrior*'s reconstruction and remediation.

Warrior is a unique game, never inspiring the legions of copycats common to many early titles. Using a clever optical illusion, it combines screen-printed art of a castle interior with two sword-wielding combatants viewed top-down using a half-silvered mirror and a vector monitor, an early alternative to the then-competing and now-dominant raster display. Lacking the memory or processing speed necessary for a computer opponent, the game requires two players, each of whom guides their warrior with a joystick or holds down the joystick's button to stand still and control the swinging sword. This bi-modal control scheme was a compromise made by the game's designer; as a result, players must switch between moving to a strong position and attacking. Guiding their vector-traced combatants around a florescent castle interior replete with staircases and a bridge between two infinite pits, players

must either guide their sword through the center of their opponent's avatar or force the enemy into one of the pits. The richly detailed knights even turn their heads to keep constant watch over their opponent. Gameplay happens at a deliberate pace, with most combat focusing on struggling over the knight's swords in a bind position, reminiscent of the famous lightsaber clashes in *Star Wars*. Players are typically defeated by being forced into a pit, being attacked while attempting to reposition, or by misjudging the range of their opponent while moving and subsequently being hit before switching to controlling their sword. One member of the modding community who has examined the code recently wrote: "The original game included an odd bit of code which seems to have the effect of simulating the knight's armor. You can't kill the other player without having some force behind your swing. What it actually means during the game is added frustration and inability to move your sword as you might like," (Shiels, 2014). After ten "time units," (30-120 seconds, adjustable by the arcade operator) displayed as a countdown on the screen, the player with the fewest deaths wins (*Warrior Operation and Maintenance Manual*, 1979, p. 4). *Warrior* was never tremendously popular, unlike fellow vector-based game *Asteroids* (Atari, 1979) or coin-devouring legends like *Space Invaders* (Taito, 1978) and *Pac-Man* (Namco, 1980), but it has nonetheless taken on the status of a "grail game," an item so desired and difficult to acquire that collectors analogize their quest with the Arthurian quest for the holy grail.

In recent years, the volume of writing on the history of videogames has flourished, from wide-ranging surveys (e.g. Herman, 1997; Kent, 2001; Wolf, 2007; Donovan, 2010), to memoirs (Baer, 2005) and biographical sketches (Kushner, 2004) of pioneering figures in game development, to in-depth analyses of time periods (Burnham & Baer, 2001; Wolf et al., 2012) and platforms (Montfort & Bogost, 2009; Jones & Thiruvathukal, 2012; Maher, 2012; Street, 2012). Other projects have focused on contextualizing and clarifying the early history of single games (Lowood, 2009; Montfort, 2009). Following that approach, this article focuses on a single title in order to analyze a history spanning five decades across multiple disciplines. In the existing academic literature, *Warrior* makes only cameo appearances, appearing in half of a paragraph in Donovan's *Replay* (2010) and ambiguously described in Wolf's *The Videogame Explosion* (2007), discussed below. There are also primary sources and articles written for popular, enthusiast, or industry audiences. I was unable to access many of the coin-operated industry magazines from the time period around *Warrior*'s release

due to a scarcity of archival holdings of this material. Two early histories collected and circulated on Usenet, one by Steve Ozdemir in 1993 and one by Bill Paul in 1996, demonstrate the confusion and rumors surrounding early arcade games during the beginning of the Internet's democratization. In 1999, two long emails, one by programmer Dan Sunday and one by Tim Skelly, circulated on Vectorlist, an email listserv for the discussion of vector-based games. More recently, Keith Smith's "The Ultimate (So Far) History of Cinematronics/Vectorbeam" (2012-2014) stands as the most authoritative source on Cinematronics, Vectorbeam and *Warrior*. This article highlights points of disagreement about and the changing motivations for discussing *Warrior* contained in these sources.

Taking inspiration from Raiford Guins' *Game After* (2014), this article looks beyond the moments of development and commercial viability to the "afterlife" of the videogame cabinet as a physical artifact moving through time and space and a shifting sets of meaning. Guins' focus on afterlife highlights the way the cultural meaning of games change through time and the way their materiality, particularly in preservation, becomes more prominent. Afterlife is in effect a study of afterlives, as different instances of the same machine end up in landfills, private collections, museums, or are transmogrified into arcade emulation machines or used as a cabinet for another game. The materiality of games has been obscured, first by separating the game from dedicated hardware in emulation or recreation on other platforms and later by trends such as digital distribution. Focusing on materiality opens up new sources of evidence for a game's afterlife, from user wear and tear to modification to stickers that reveal licensing and ownership information.

Using archival resources, personal correspondence, first-hand gameplay experience with a working instance of the arcade cabinet and previously published interviews and listserv discussions with creators of the game, this article attempts to account for *Warrior*'s genesis and lifespan. In so doing, it does not strive to be a definitive text of only undisputed facts. Instead, it seeks to bring competing and contradictory accounts into conversation, declining the veneer of unitary authority in favor of capturing and appreciating the value of the ambiguity that exists at the time of writing. As time passes and early games begin to recede from living memory, all future scholars will be at the mercy of what video game historians, curators, collectors and creators write and preserve. This effort stands as a test of the

progress so far and emphasizes areas where records are incomplete or call for further research.

Warrior in Circulation: The Player and the Operator

Figure 2. Warrior arcade cabinet. Photo International Center for the History of Electronic Games (Creative Commons 3.0, By-NonCommercial-NonDerivative)

Warrior lacks the spectacle of near-contemporary *Hercules*, a mammoth pinball machine dubbed the largest ever made (Atari, 1979), large multiplayer pieces like *Tank-8* (Atari, 1976) or *Star Wars: Arcade Racer* (LucasArts, 2000). It has a typical upright form factor not unlike classics such as *Pong* (Atari, 1972) and *Space Invaders* (Taito, 1978) (Fig.1). On closer inspection of the cabinet's exterior, however, it begins to stand out. While titles such as *Pac-Man* (Namco, 1980) featured illustrations suited to a cartoon and Williams Electronics' titles of similar vintage such as *Defender* (1980) or *Joust* (1982) featured bold three-color side panels seemingly printed with a dark arcade or barroom in mind, *Warrior* has a highly detailed full-color screen print drawn by Frank Brunner (*Warrior Operation and Maintenance Manual*, 1979, p. 4), a Marvel artist for titles such as *Dr. Strange* (Smith, 2012b, pt. 4; Cody, 2000).

Few figures are neglected as much as the operator in the history of the video game. Several of the operators I attempted to contact for this article either had little memory of individual games and their tenure, or were unwilling to participate. Cowan's consumption junction (1987), an analytical focus on technological artifacts from the perspective of their purchasers and the markets they were part of, is a productive starting point for game purchases centered around the home and accessible to middle class consumers, such as the majority of home console and personal computer games. However, arcade machines in the late 1970s were prohibitively expensive for consumers, and were typically purchased by small business owners who either operated the machines on their own premises, which might be exclusively devoted to an arcade or part of an unrelated venture, or leased the machines to other businesses on a "route" travelled for the collection of coins and for periodic maintenance.

Operators existed prior to electronic games, dealing in pinball machines, jukeboxes, slot machines, and electro-mechanical games. As a result, trade publications from the 1970s such as *RePlay*, *Play Meter,* and *The Amusement Review* are a valuable source of information on early video game sales, marketing and distribution. In contrast, the first magazines dedicated to video game consumers, *Electronic Games* and *Computer and Video Games*, began publication in 1981, although other consumer-related magazines included games coverage, such as the "Arcade Alley" column in *Video* magazine beginning in 1978 (Kohler, 2011). According to an advertisement in the May 1979 issue of *Replay*, Cinematronics had fifty-five distributors throughout the U.S. and Canada at the time of *Warrior*'s release. An operator contacted for this article was impressed in the late 1970s by the unique way *Warrior* looks and sounds at a trade show hosted in Chicago by the Music & Amusement Operators Association before purchasing his machine from one such distributor, Cleveland Coin, International (Mike Reynolds, personal correspondence, 2013). During this machine's commercial peak, it shared the arcade floor with a variety of pinball machines as well as *Space Invaders* (Taito, 1978), *Asteroids* (Atari, 1979), *Night Driver* (Atari, 1976), *Stunt Cycle* (Atari, 1976), *Galaxian* (Namco, 1976), *Battlezone* (Atari, 1980) and *Boot Hill* (Midway, 1977).

In a dark environment, close enough to the machine to peer down into *Warrior*'s display, the player sees the vibrant combination of vector graphics with hand-drawn art reflected onto a half-silvered mirror from the purplish glow of a blacklight. Unlike most games, the monitor is not directly visible to the player, but is instead mounted with its screen facing up beneath the control panel. To see the playfield, participants must stand close to the machine and look down into it. Spectatorship from behind players is difficult if not impossible. Placement within the cabinet partially shields the display from outside light; because *Warrior* relies on reflections for its optical illusion, it is particularly susceptible to glare. A cardboard

Figure 3- Warrior cabinet side-art, ICHEG archival machine. Photo by the author.

screenprint of a brick wall and four fire pits face the player where most machines would display the screen. The monitor produces the stark white outlines of each player's warrior, along with the current score and the time remaining in the match. Above the monitor, slanted at an acute angle, is Brunner's hand-drawn castle interior that the players' avatars traverse. That image is reflected onto a mirror directly behind and below the control panel, which flips the image and projects it onto the half-silvered surface, creating the illusion that the electronically generated graphics and the hand-drawn art exist on the same surface. While capable of generating only four different sounds—"a pit fall, explosion, reappearance hiss and two levels of sword hum" (*Warrior Operation and Maintenance Manual*, 1979, p. 20) the monaural speaker mounted just above the coin mechanism is remarkably loud, even at its lowest setting.

Given the dominance of the computer in contemporary society, it is tempting to overemphasize its role in the history of arcade games. Perhaps historians of electronic games are more comfortable in the computer lab than the barroom. However, *Warrior* is a valuable focus for study precisely because it requires acknowledging roots of the videogame beyond the digital, turning not only to the analog but also the domain of popular entertainment. A review of early magazines of the nascent arcade game industry in the mid-to-late '70s, such as *Amusement Review*, *Replay*, and *Play Meter*, makes this clear: arcade games are often portrayed as novelty items and the pages are dominated by advertisements for pinball machines and bestseller charts for jukeboxes. Given that business operators have plied customers for coin in return for a taste of automated amusement since the 19th century (Costa, 1988) and the earliest arcade cabinet prototypes were evaluated in bars (Donovan, 2010, p. 20), it should be unsurprising that the cultural practices of public places of entertainment and the technologies of the amusement industry would have a strong influence on the early history of electronic games. Furthermore, players from that time period would likely find the appearance of techniques and technologies from electromechanical games and the amusement industry to be a logical extension of what they were accustomed to encountering in similar spaces, while later generations of gamers are unlikely to have a field of reference for the optical illusion and subsequently may view it as exotic. For contemporary game scholars or enthusiasts who come across a mention of *Warrior* in the literature and seek to see it in action, no video of the arcade machine being played appears to

be on YouTube, Vimeo or fan sites (although evidence of video of the game previously available exists in the Internet Archive snapshots of Superzapper.com from roughly 2000-2002). Due to the analog nature of the original game cabinet and its variant on cathode-ray tube technology (discussed below), authentic emulation of its appearance on modern computing systems is unfeasible. I turn to the emulation of *Warrior* at the conclusion of this essay.

Moreover, according to Kirkpatrick's account (2012), what we now recognize as the "gamer" identity had not yet formed at the time of *Warrior*'s release. Players of that time period lacked the lexicon of genre that shape current discussions. Many contemporary players had trouble making sense of *Warrior*—the owner of the machine at Pinball Pete's, the site of the final public machine discussed at the beginning of the article, had to put a sign on the cabinet emphasizing that the game required two players after complaints from patrons that the machine was broken (personal correspondence, Mike Reynolds, November 2013), although many notable games from the time period also required two players (e.g. *Pong*, Atari, 1972).

As for gamers of the present day unfamiliar with the state of arcade gaming at the time of *Warrior's* release, they are likely to be shocked not only by the tremendously vibrant combination of digital and analog imagery, but also by the lack of visible pixelization, a visual motif as suggestive of the early period of electronic games to current gamer culture as Pac-Man, Donkey Kong, or the Space Invader. To understand why *Warrior* lacks pixels and the origins of its detailed hand-drawn backgrounds, we have to turn to the electronic display technology and the optical illusion that made its aesthetics possible.

Natural Magick

The use of a half-silvered mirror to give the appearance that multiple objects from different perspectives and spaces occupied the same plane was widespread in the genre of electromechanical games that preceded video games. The technique was described in depth in the first published article on the history of video games (Bristow, 1977)— as a hallmark of their electromechanical predecessors, recognized as still competitive with early videogames. Bristow, then the Vice President of Engineering at Atari, described three limitations of the electromechanical games: their use of labor-intensive mechanical components, the cost of

electromechanical components, and the limited motion and number of objects feasible. According to Bristow: “To get around these limitations and to allow better games, the first video games were created” (1977, p. 58). Skelly himself acknowledged that he was inspired to use the half-silvered mirror to combine *Warrior*’s digital characters with a hand-drawn background, and attributes its origins to “the early days of magic” (Cody, 2000).

Indeed, combining multiple images on a half-silvered mirror far predates video arcade games, and even the electromechanical games that proceeded them. Stretching back to the 16th century, Giambattista Della Porta, an Italian playwright, occultist, and early scientist, describes a similar method of combining the reflection of various objects on a single surface in a segment titled "How we may see in a Chamber things that are not" (1658 English translation of 1584 *Magiae Naturalis*):

> For we may in any chamber, if a man look in, see those things which were never there. […] Wherefore to describe the matter, let there be a chamber wherein no other light comes, unless by the door or window whence the spectator looks in. Let the whole window be covered in glass, but let one part be polished, that there may be a looking glass on both sides, when the spectator must look in. […] For what is without will seem to be within, and what is behind the spectators back he will think to be in the middle of the house, as far from the glass inward, as they stand from it outwardly, and think he sees nothing but the truth.

Friedrich Kittler identifies this very description as a forerunner to the development of the *camera obscura* and part of the lineage of modern cinema (trans. Enns, 2010, p. 53); video games too have a deep history. An inventor named Henry Dircks developed a variation of della Porta’s illusion with the use of plate glass; in the 1860s, London’s Royal Polytechnic Institution,[1] which combined the popularization of science with demonstrations of illusions, inventions and popular education, incorporated the illusion under the direction of “Professor” John Henry Pepper (Brooker, 2007). Due to the success of the illusion at the Royal Polytechnic Institution, it became popularly known as “Pepper’s Ghost.”

[1] Now known as the University of Westminster.

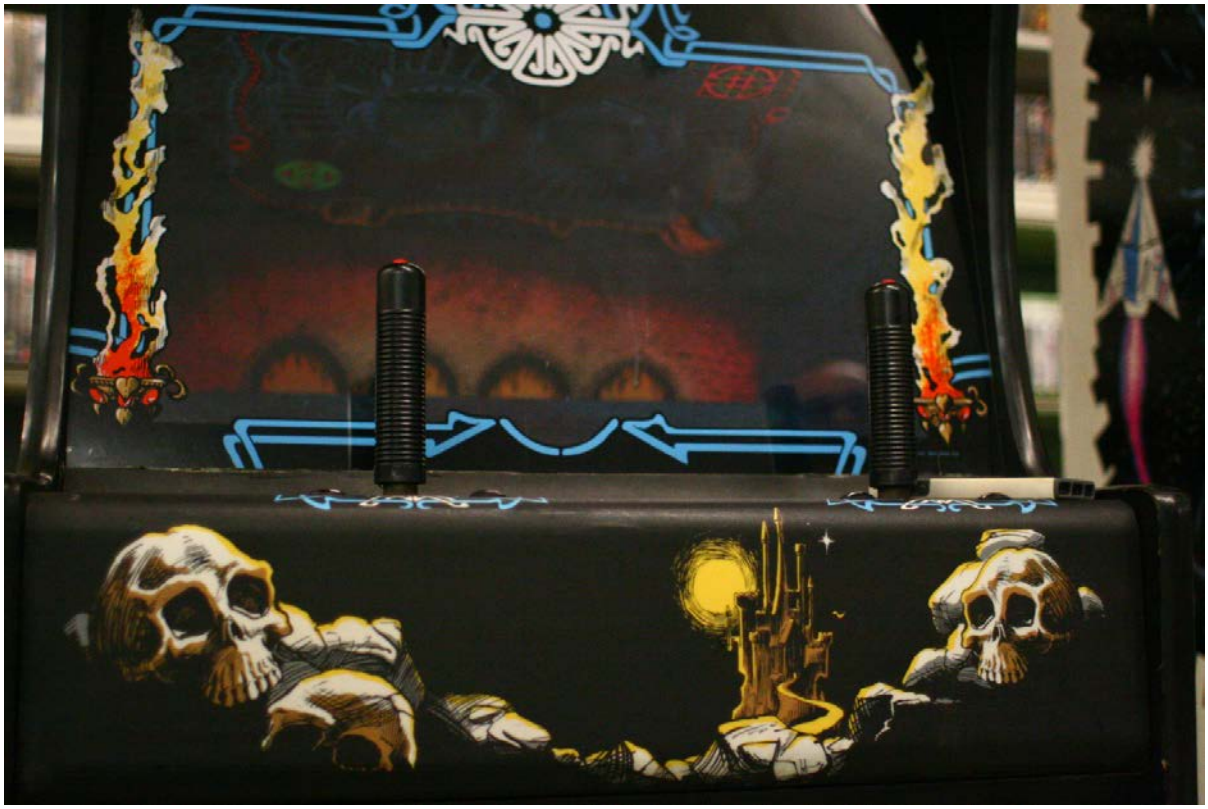

Figure 4: from this perspective, the castle interior painting which is reflected on the playfield below is clearly visible.

The Pepper's ghost effect was widely used in electromechanical games that were near contemporaries of *Warrior*, such as *Shootout* (Chicago Coin, 1976), as well as fellow vector game *Asteroids Deluxe* (Atari, 1981). More recently, it was used to overlay a digital screen over a traditional pinball playfield as late as the last gasp of the major pinball manufacturer, Williams' Pinball 2000 system used in *Revenge from Mars* and *Star Wars Episode I* (1999).

Technological Transfer:

Space War(s)(!) from MIT to Cinematronics by way of *Computer Space*

Just as Lowood (2009) tells us of *Pong*, the "winding path" of *Warrior* begins at *Spacewar!* (Tech Model Railroad Club, 1962). Lawrence ("Larry") Rosenthal graduated from the Massachusetts Institute of Technology (Kent, 2001, sec. The Golden Age Begins),[2] the home

[2] N.B. Kent claims that Rosenthal's version of *Spacewar!* improved upon the original by converting it to vector graphics. While Nolan Bushnell and Ted Dabney's version (*Computer Space*, Nutting Associates, 1971) used raster display technology, the original *Spacewar!* was displayed on an oscilloscope using similar principles to Rosenthal's implementation.

of *Spacewar!* (see Brand, 1972). While Kent and Paul (1996) claim that Rosenthal wrote his master's thesis on *Spacewar!*, Rosenthal actually received his master's in Electrical Engineering at the University of California, Berkeley, with a thesis titled "Machine classification of multiple-unit action potentials: research project" (Rosenthal, 1973). In fact, Rosenthal saw others play *Spacewar!* during his time at MIT, but claims to have never actually played it himself (Rosenthal, 2014, 30:56), but instead played Bushnell & Dabney's *Computer Space* (Nutting Associates, 1971), the first commercially sold coin-operated video game, on a visit to MIT's campus after completing his master's degree (Rosenthal, 2014: 32:05). Rosenthal began work on his prototype of a *Spacewar* clone in 1973 and was able to produce vector images by 1974 (Rosenthal, 2014, 2:10). He eventually filed U.S. Patent Nos. 4053740 and 4027148, which describe a self-contained computer system for running an arcade game and a vector monitor (Rosenthal, 1977). By adapting a commercial raster-based CRT monitor with his own circuitry controlling the electron gun that traces the image on the monitor (2014, 38:01), Rosenthal had a viable way of using readily available commodities to create an arcade machine. After shopping his technology around to many in the industry using a prototype built into a Samonsite suitcase (and, according to Skelly, being widely rejected for his request for 50% of revenue from his version of *Spacewar!*), Rosenthal found a buyer in Cinematronics (Skelly, 2012, 141). Notably, Rosenthal himself has recently disputed the 50% royalty figure (Smith, 2012b, Pt. 3), instead putting the figure at 5% (Rosenthal, 2014, 0:03). Founded in 1975 in El Cajon, California, Rosenthal's partner corporation Cinematronics got its start by selling a *Pong* copy (Smith, 2012b, Pt. 1, sec. "Sidebar - Cinematronics' *Pong* Clone). Its subsequent games performed poorly, but Rosenthal's game, renamed *Space Wars*, became the first vector-based game widely released to the arcades. It sold more than 10,000 units according to Tristan Donovan's *Replay* (2010, p. 84) and more than 30,000 units, with a three year reign in the top ten of best-selling arcades in *Replay Magazine,* according to Skelly (2012, 142). In Rosenthal's recollection (2014, 5:02), however, only 8,000 total units were built between Cinematronics and Vectorbeam: the companies simply did not have the capacity to produce 30,000 units during the peak of the game's popularity. Paul (1996) puts the run of most Cinematronics games at 5,000 units, explaining:

> The game industry at the time was a seasonal business. Games would be designed and the software written in the summer. There would be a small production run for

> samples and trade shows in the fall. Assuming all went well, the distributors would place their orders shortly after the trade show, and they would start making games as fast as they could.

Warrior, however, was not published by Cinematronics alone. We turn now to Vectorbeam and its namesake technology.

Vectorbeam: the Company and Platform

What separates vector display technology, also referred to as X-Y display (for x, y coordinates) and as Quadrascan by Atari, from typical cathode ray tubes in televisions and computer monitors? Using a platform studies approach (Bogost & Montfort, 2009), we can understand the technical affordances and limitations of the hardware and better appreciate the material constraints that shaped *Warrior*'s design. Early video games such as *Spacewar!* and *Tennis for Two* (Higginbotham, 1958) used an X-Y display presented on an oscilloscope, which uses a different technology for generating images on the screen but follows the same coordinate-based principles. Consumer televisions used raster scan technology, which begin firing an electron beam at the phosphors in the top left-hand corner of the screen, then proceed quickly across the row, activating the beam to draw pixels in some segments, before returning to the left-hand side of the screen on the next row, and so forth until the entire screen is traced and the process begins again at the top, thereby completing one "frame" (Rubin, 1998; Montfort & Bogost, 2009a, p. 83). This process happens so rapidly (from twenty-four to thirty times per second in major film and television formats) that the human eye perceives change between multiple frames as movement due to the persistence of human vision and the persistence of illuminated phosphors. An X-Y or vector display, on the other hand, directs the electron beam to any coordinate, turns on the beam, and then moves to any other coordinate, drawing a straight line in between.[3] The vector traces can even be programmed to spend a longer amount of time on one point, thereby increasing the luminance of the image at that point, a technique used in *Asteroids* (Atari, 1980) and its successors. Because the X-Y display system can move freely from point to point, it is not required to break the images it could create into small rectangles known as pixels (or subsequently hold

[3] In practice, lines can only be so long; for example, drawing a line from one side of the screen to the other required two connecting lines (Shiels, personal communication).

information for each of those pixels), and is just as capable of drawing a straight line diagonally as vertically or horizontally. As a consequence, vector-beam displays were capable of much higher levels of resolution than raster displays and can smoothly rotate images, but were capable only of drawing outlines on a black background that could not be "filled in" with color. The Vectorbeam system is also only capable of generating a white light at two levels of intensity, rather than the sixteen colors of a near-contemporary raster-based game such as *Defender* (Vid Kidz, 1980) (Camper, 2012).[4] Over the long-term, the amount of memory available for storing information for each "frame" increased, as did the density of pixels available on a monitor, allowing raster graphics to dramatically improve.

What do these technological affordances mean for *Warrior*? The higher resolution of the vector display allowed for a much greater level of detail than that available to raster-based games; compare the richly detailed knights of *Warrior* with the blocky protagonist of *Pac-man*, for instance. Being able to freely rotate images allows players to engage in combat in three hundred and sixty degrees, with no privileging of the cardinal directions prevalent in other games. We might think again of the four directions of movement built into the level design of *Pac-Man.* On the other hand, the design of the vectorbeam system limits the amount of phosphor that can be illuminated at one time. As a result, vector-based games cannot offer the “filled in” background of later raster games, prompting *Warrior*’s screen-printed background. Limitations on how much can be drawn by the vector in a single cycle may have also prevented Skelly from providing a digital representation of the pits in the middle of the playfield. Without the screen-printed background, *Warrior* is very difficult to play.

Tim Skelly, the designer of *Warrior* as well as many other early games for Cinematronics, joined the company in the fall of 1978—arriving the day after Larry Rosenthal left El Cajon and Cinematronics to start his own company, Vectorbeam, in Union City, California, and took all of the documentation and development hardware required for programming his platform with him (Skelly, 2012, 143). Rosenthal clarified that the development hardware was his personal property, and that he took the instructions on the advice of his lawyer, in the

[4] However, Atari's Color-Quadrascan on games such as *Tempest* (1981) later introduced colorized vector graphics.

words of Rosenthal a “dumb, dumb stupid mistake” and “the one thing I’m not proud of” (2014, 7:28). Given *Space Wars'* success and their previously negotiated right to produce more games based on Rosenthal's hardware, Cinematronics resolved to focus on vector-based games, despite the fact that they had no personnel who knew how to create new programs for the system or the documentation to tell them how to do so. With the assistance of hardware engineers and a copy of the programming manual made by a former technician, Skelly was able to figure out how to program games on the Cinematronics platform, and before designing *Warrior* had completed *Starhawk* (Cinematronics, 1978) and *Sundance* (Cinematronics, 1979) (Smith, 2012b, Pt. 3). Skelly went on to work in the games industry for several decades with Sega-Gremlin, Gottlieb and Microsoft; during that time, he gave many interviews on his time at Cinematronics and wrote a history that was eventually published (Skelly, 2012). Outside of a few anonymous forum posts and blog comments and an email account from Dan Sunday, Skelly’s was the only first-hand account of Cinematronics’ history until Larry Rosenthal delivered a lecture on his time at Vectorbeam at California Extreme, a collector’s showcase for pinball, video games, and other gaming artifacts, in 2014. As a result, Skelly was also the de-facto source for information about Rosenthal, although the two had met only briefly during Skelly’s initial interview.

For *Warrior*, Skelly drew inspiration from the Elric novels of Michael Moorcock, having read them while waiting for programs to compile while working on previous titles (Skelly, 2012, p. 3263). The game was developed over the course of three months (Rothe, n.d.). He seems to have relied on little if any prior art in the field of arcade game design. Skelly, a long-time comic book fan who once interviewed Jack Kirby on his college radio show (*The Daily Northwestern*, 1971), was able to commission Marvel artist Frank Brunner at the San Diego Comic Con to draw the cabinet art and the intricately detailed castle interior that would provide the background (Skelly, 2012, 150). By making the warriors relatively small, Skelly was able to draw a high amount of detail on their figures before having to trigger the "watchdog" circuit, a safety measure implemented by Rosenthal to keep the cathode ray projector from misfiring and damaging the monitor (Skelly, 2012, 152-153). Notably, Atari’s failure to correctly implement a watchdog circuit in its later Quadrascan system has been identified as the factor that ultimately killed vector gaming (Rubin, 1998). Given the complexity of the figures, Skelly only had spare vector capacity for representing the score

and the amount of time left in the game. Luckily, the background would be filled in by the blacklight-lit, hand-drawn art of Frank Brunner.

Business Intrigue, On the Market, Conflicting Accounts

While Tim Skelly was still employed by Cinematronics in El Cajon, workers at the Vectorbeam factory in Union City, California, more than eight hours away by car, built the *Warrior* cabinets in 1979, with screen-printing done by R&N Silkscreening, Inc., in San Jose, California.[5] Frank Brunner lived nearby, and Skelly was present at the Vectorbeam factory only twice (Skelly, 2012, 153). What led Cinematronics to build *Warrior* in the plant of Larry Rosenthal, their one-time business partner and erstwhile competitor?

Warrior is the only game that launched with the brand logo "Vectorbeam, A Cinematronics Company." Unfortunately for Larry Rosenthal, not long after leaving Cinematronics, his start-up ran into difficulty. Vectorbeam originally produced a virtually identical version of Cinematronics' *Space Wars*, titled *Space War* (Vectorbeam, 1978), before Rosenthal designed *Speed Freak* (Vectorbeam, 1978) and, with the help of a programmer named Dan Sunday, *Scramble* (Vectorbeam, 1978) (Smith, 2012a). The demand for these games was insufficient to keep the production lines at Vectorbeam active, however, and Tom Stroud and Jim Pierce soon repurchased the company of their prodigal programmer (Skelly, 2012, 152) for "a substantial amount of cash" (“Vectorbeam Snapped Up by Exidy,” 1979, p. 66) along with the patents underlying the Vectorbeam technology (Smith, 2012b, Pt. 3). Rosenthal’s liabilities to the Internal Revenue Service and the demands of payroll at Vectorbeam were consuming his royalties from the Vectorbeam patents, and he was worried about getting in over his head, motivating the sale (Rosenthal, 2014, 19:54). With a new production facility in Union City, CA, Cinematronics moved production of *Warrior* to the Vectorbeam factory under the direction of Tommy Stroud, Jr. *Warrior* would be the only game Cinematronics made in Union City; despite a claim by Skelly to the contrary (2012, 156), contemporary media reports indicate that the Vectorbeam factory was not shuttered by Cinematronics, but purchased by Exidy, (“Vectorbeam Snapped Up by Exidy,” 1979; “Exidy Buys Vectorbeam,” 1979, p. 6) which also bought the rights to *Tailgunner II*. Dan Sunday, a

[5] The company's participation is documented on the bottom right hand corner of the arcade machine's front bezel.

programmer who worked with Rosenthal at Vectorbeam, also confirms Vectorbeam's sale (Moore, 1999). An article in *Replay Magazine* claims that Exidy took over while *Warrior* was still being produced, and that Exidy marketed *Warrior* for a period of time ("Exidy Buys Vectorbeam," 1979), a claim that other sources did not verify.

Rosenthal's appearance at California Extreme in 2014 introduced more complexity and depth to the narrative established in the 1990s and 2000s. His lecture has a fascinating rhetorical frame: Rosenthal stands on stage, reading excerpts from Skelly's accounts over the years, Smith's "The Ultimate (So Far) History of Cinematronics/Vectorbeam" and other articles, offering his light-hearted corrections, significantly re-shaping the historical record of Vectorbeam and Cinematronics. He also presents a pivotal artifact, the original prototype of his vector display system, built into a Samsonsite suitcase, as a mute testimony to his authenticity. At one point he reads from a highlighted print-out, "Rosenthal left the game industry, never to be heard from again…" before looking up at the audience and adding, "I guess, until today!" cuing applause from his audience (2014, 8:25). His appearance adds considerable depth to our knowledge of Vectorbeam and Cinematronics, although Rosenthal had nothing to say about *Warrior* and seemed to have little interest or knowledge of games developed for his system after he left the industry.

While *Warrior* was developed at Cinematronics by Skelly, a Cinematronics employee, in the manual that shipped with the cabinet, Cinematronics goes unmentioned—*Warrior* is referred to exclusively as a Vectorbeam game (*Warrior Operation and Maintenance Manual*, 1979). While Skelly writes that he "designed all of the game cabinets and hired the artists to execute the cabinet art" (Skelly, 2012, 140), he attributes the craftsmanship of the *Warrior* cabinet to Tommy Stroud, the son of Cinematronics' owner, Tom "Papa" Stroud (Skelly, 2012, 151). Released in September of 1979, [6] *Warrior* was likely priced at around $2,000 when sold to a distributor (Skelly, 2012, 142), the equivalent of $6,433 in 2013, according to the U.S. Bureau of Labor Statistics inflation calculator. To put that price into perspective, an operator around *Warrior*'s release taking a fifty-percent split of revenue from the game, a common

[6] Some sources claim October 1979 as the game's release date, such as the Arcade History website. See http://www.arcade-history.com/?n=warrior&page=detail&id=3144 Earlier information from the mid-90s, such as Ozdemir (1994) and the digital copies of the assembly code of the game available on the internet claim the game was released and copyrighted in 1978.

arrangement between distributors and arcade owners, would need players to sink $4,000 dollars, the equivalent of 16,000 quarters, or at 30-120 seconds per game, about 134 to 534 hours of playtime for *Warrior* to break even at $2,000. Distributors doubtlessly marked up the game considerably to turn a profit, increasing the preceding figures by anywhere from ten to thirty percent.

The Collected *Warrior:* Preservation and the Grail Game

In 2008, gaming website IGN claimed there was only one known working *Warrior* cabinet (Fahs, 2008). The most popular registry of classic arcade games as of 2013, The Killer List of Video Games (KLOV), maintained by the Internet Arcade Museum and populated with information volunteered by members of the Vintage/(Video) Arcade Preservation Society, records six known working instances of the game, all located in the U.S. Based on the information provided in the database, this listing does not include the aforementioned machine at Pinball Pete's, a fully restored cabinet working as of 2006 in the UK (Edge staff, 2006), a unit in storage in Wisconsin owned by a dealer known as "Pac-man Pat" (personal correspondence with Dino Manzella, November 18th, 2013), the instance owned by Manzella discussed below, and the archival instance of the game held by the International Center for the History of the Electronic Game at the Strong National Museum of Play. The Strong currently holds a working *Warrior* machine as part of its archive, making it available to researchers and rotating in through public exhibitions. The Strong last made its copy of *Warrior* available to the public in the summer of 2013 as part of its Boardwalk Arcade Exhibit (Saucier, 2013). According to their archive listing, the Strong's unit was purchased as an acquisition from the Videotopia collection, a traveling exhibit of vintage arcade machines. Parts are a particular concern for the ongoing preservation of *Warrior*: vector monitors are relatively rare, have not been produced in decades, and are repaired by very few technicians. The joysticks for the game were custom-made by Cinematronics (Skelly, 1999) and replacements are very difficult to find. Furthermore, the internal electronics in many Cinematronics and Vectorbeam games have begun to fail. Mike Shostak, doing business as Cinelabs (www.cinelabs.com), announced plans to create new electronics and a multigame board (i.e. many games on a single chip) for all Cinematronics titles some time in the early 2000s; his website has not been updated since 2006. Vector Labs (vector-labs.com) reproduces multigame boards for color titles, but has not yet reproduced monochrome games

like *Warrior*. Timothy Shiels is currently in the process of reproducing *Warrior* sound boards. Given the fragility of its components and the finite supply of viable replacements, *Warrior*'s continued existence as a playable game, even in the archive, is extremely uncertain. While parts are still available, however, the upkeep of vector games is also an opportunity for their devotees to understand them more deeply in the process of maintenance and rebuilding.

Due to its scarcity and desirability, *Warrior* is sometimes referred to among collectors as a "grail game," a game so difficult to find and so desired that it is compared to the Arthurian holy grail, on the Vintage Arcade Preservation Society (VAPS) community forums. VAPS members often list their grail games, discuss their "quest" to find them, and debate the most sought after games (and whether they are worth the trouble). In 2011, VAPS member "djw90" asked how many others were interested in reproducing the game and three other users indicated their interest ("Reproduction Warrior cabs," 2011). In a thread on hard-to-find arcade machines, one VAPS member, "lintzgm" revealed that he had been searching for a *Warrior* machine for fifteen years (2012). While researching this article, I came across various posts by another collector interested in a reproduction, Dino Manzella. When I first contacted him in 2013 (personal correspondence), Manzella was trying to gain first-hand access to a *Warrior* machine so that he could take measurements and photographs necessary to create a reproduction of the arcade cabinet with a modified version of the game code (discussed further below). After more than a year of searching for the game online, he was able to purchase the machine from a Canadian collector in late September of 2014, for a little more than $5,000 including shipping. While *Warrior* is a valuable and rare arcade cabinet in the collecting community, it has ultimately depreciated in value from its original price of $2,000 in 1979 after adjusting for inflation, losing approximately 20% of its value from its original sale price. It is vital for scholars to keep in mind that arcade games which now sell for a few hundred dollars were much more expensive when they were new products intended as a durable capital good for amusement operators, far out of reach of the vast majority of players.

Novelty & History: *Warrior* as First Fighting Game?

Sources before 2009 list *Warrior* as the first one-on-one fighting game (Cody, 2000; Wolf, 2007; Fahs, 2008; Green, n.d.). Some acknowledge precursors, but give *Warrior* a pass on a technicality: "some early boxing games like *Heavyweight Champ* and Atari's *Boxing* that could be seen as brawlers, but never had the fight been taken out of the sports arena" (Fahs, 2008, sec. Fighters Get Medieval). Skelly himself notes that the game was long considered the first one-on-one fighting game, and that an anonymous editor corrected the record on Wikipedia, crediting *Heavyweight Champ* (Sega, 1976) as the first fighting game with a link to the Killer List of Videogames on April 10th, 2007. Previous scholars and historians seem to have overlooked a much more pertinent game to the first fighting game debate which is immune to the caveats of distinctions between "fighting" games and "sports" titles, an early black and white arcade game called *Knights in Armor* (Project Service Engineering, 1976) which allowed two players to each control the sword and shield of a black knight and a white knight jousting. No working copy of the game is listed on KLOV, and little information is available (see gregf, 2012). It is difficult to pinpoint which was released first in 1976 between *Heavyweight Champ* and *Knights in Armor*, as the month of release has not been published for either game; *Knights in Armor* was at least advertised in the May issue of *Play Meter* (1976).

Three Moments of Rebirth

Beyond its original arcade incarnation, there are at least three recreations of *Warrior*: the emulation of the game to run on modern Intel-based processors, a port released for the Vectrex, a home console with a built-in vector monitor, and an ongoing effort to reconstruct *Warrior* as an arcade game with a modified control scheme. All three projects demonstrate that *Warrrior* has a lifespan beyond its original materiality.

In the late 1990s, programmer Zonn Moore developed an emulation of the Cinematronics platform, allowing the recreation of the vector-monitor portion of the game on modern computing hardware. Released in 1997, the emulator was a verification of Moore's reverse engineering of the Cinematronics CPU and programming system; he finished documenting the platform in 2000, providing programmers with everything they need to understand a title's decompiled code, modify existing code, or create their own titles for the hardware. Of

course, only the vectors are emulated, meaning that *Warrior* is very difficult if not impossible to play as intended, as the two infinite pits in the middle of the combat arena are not visible. Aaron Giles, a major contributor to the *MAME* project, added support for the Cinematronics Vector System and *Warrior* in 1999 (MAME 0.35b6, 1999). MAME can render a raster background below the vector image, making the game much more playable. In any case, the vectors are given a pixelated appearance inconsistent with the smooth lines of the original hardware as they are rendered on low-resolution raster emulators. The only video readily available on YouTube of *Warrior* at the time of this publication is an emulated version with a raster background, and the description does not indicate it is emulated; many who watch the video likely have little idea of how different the original game appears.

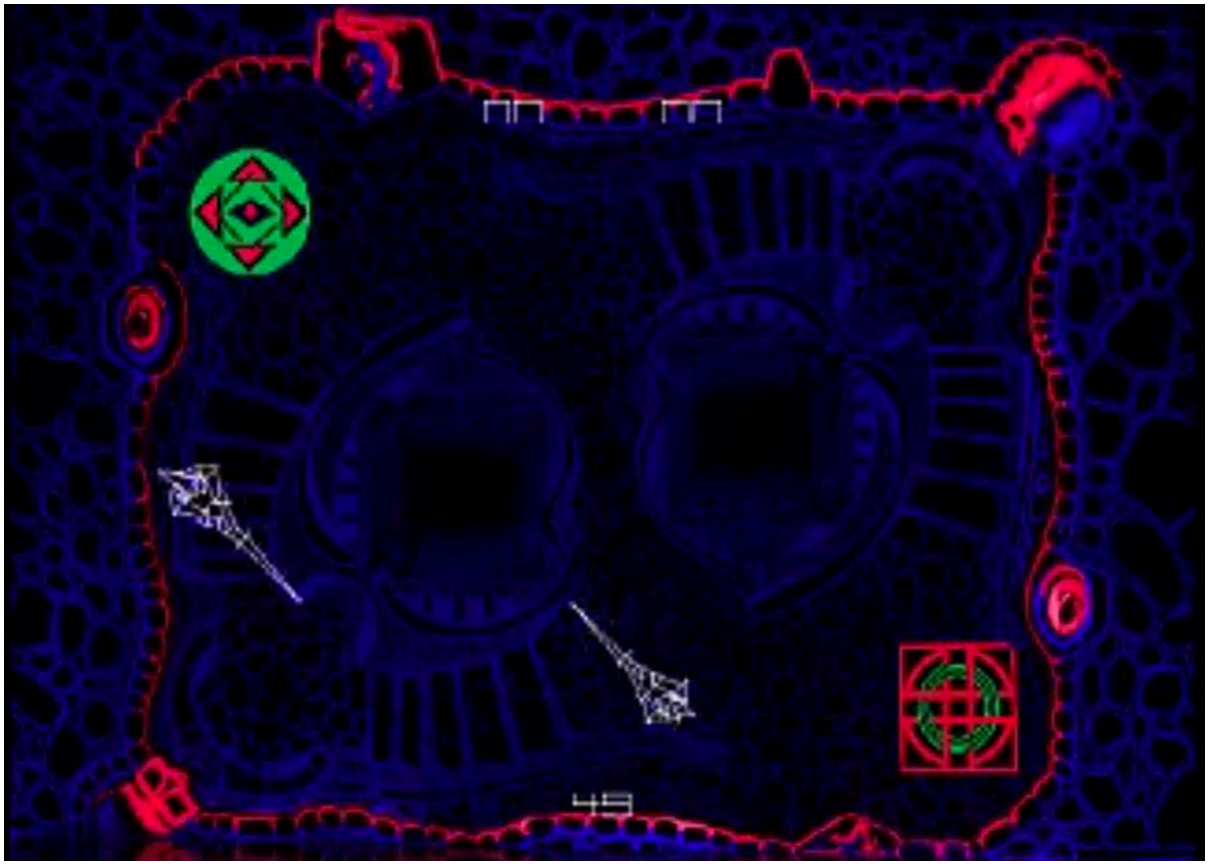

Figure 5 - screenshot of emulation by thedoteaters.com

Emulation is always a selective recreation of the original game, with many of the material characteristics of a game impossible to convey in the medium of another computer. This is an especially acute problem with *Warrior* because it uses a fundamentally different digital

display technology and an analog display. On the other hand, displays such as Apple's Retina for the iPhone offer such high pixel density that they offer an opportunity for once again making the pixel invisible; they could in turn provide a somewhat more faithful rendering of *Warrior*.

Warrior has also been ported to another system: the Vectrex, the only vector-based home console ever released. The Vectrex was released in 1982 by General Consumer Electronics (later bought by board game juggernaut Milton Bradley) that used a built-in 9-inch vector monitor display and a cartridge system to store games, many of which were licensed from Cinematronics (Barton & Loguidice, 2007). Like the Cinematronics/Vectorbeam cabinets, it had a monochrome monitor; transparent plastic overlays came with each game, fulfilling a similar purpose to Warrior's half-silvered mirror. *Warrior*, however, was not developed for the system when it was still being marketed. Many "homebrew" games, usually created by independent amateur developers who make cartridges to run on original hardware, have been released for the system, beginning in the mid-1990s and continuing to the present day. Homebrew developer George Pelonis, doing business as Fury Unlimited, announced a limited edition of 100 *WARRIOR 2012* cartridges in 2011 for $65, touting features such as a single-player mode, a new custom overlay and several new character models. Due to demand, that run was later increased to 150 copies. However, production of the game was troubled; searching for the game online reveals sometimes acrimonious forum threads and discussions about delays, problems with the complexity of the programming and printing errors with the overlays. Some pre-orders were apparently still unfilled in late 2014. Due to these difficulties, *Warrior*'s Vectrex remake may be as rare as its arcade forebear.

As discussed above, Dino Manzella read that Skelly originally intended *Warrior* to have a "dual-stick" control scheme on Wikipedia, with movement and sword movements controlled both independently and simultaneously. Skelly himself stated that he tested a version with two joysticks, but "the task was like rubbing your stomach and patting your head at the same time" for playtesters (2012, 150)—arcade players at the time had never encountered dual-stick controls allowing motion and aiming at the same time, a technique popularized by *Robotron 2084*. He began posting on forums like VAPS, looking to acquire a machine and evaluate the difficulty of modifying *Warrior* to allow simultaneous controls. He contacted

Timothy Shiels, creator of the website Outerworld Arcade, who had begun documenting *Warrior*'s code in 2010. Shiels (2014) discovered evidence in the code that suggested it was originally intended for four joysticks, and eventually released a modified game file playable through MAME (Multiple Arcade Machine Emulator). (As discussed in the beginning of this article, Shiels also discovered that *Warrior*'s collision system attempted to recreate the effect of "armor" on a knight by requiring a sword to be moving at a certain velocity to kill an opponent). Manzella still plans to clone the *Warrior* arcade cabinet for the modified version of the game and this project is ongoing. Manzella and Shiels' effort is a small-scale analog to the current efforts of fans to create their own patches, updates and servers for discontinued titles.

While *Warrior* and many games of its era may no longer be playable in the coming decades, these moments of recreation demonstrate that the essence of a game's design may well outlast its physical incarnation, provided sufficiently dedicated fans take on this task. Of course, the legality of any of these adaptations is unclear: a vigorous defense of the *Warrior* IP may very well have made these efforts at reconstruction infeasible.

Conclusion: The Bit-Rot of Game History

Many questions remain about *Warrior*'s past and future. Ownership of the legal rights to *Warrior* is uncertain. In 1997, Tim Skelly signed over the rights to all of his games for Cinematronics to Williams/WMS Industries (Skelly, 2012, 164), which left the electronic game market the next year and was sold to Scientific Games Corp. in January of 2013 (Palmeri, 2013). As vector monitors continue to be lost to the passage of time and inevitable attrition, and as no new vector monitors have been produced for many years, the long-term options for keeping *Warrior* operational, even in the archive, remain similarly murky. Despite the wealth of information on *Warrior* recorded by fans and its creators, basic information like the number of cabinets manufactured or its exact selling price has eluded the author.

While this article tries to sort through conflicting accounts of the history of *Warrior*, many sources of information remain inaccessible. Like most video game histories, this account still privileges the contribution of the game designer, Tim Skelly—much remains to be learned

from the perspectives of those who prototyped the *Warrior* cabinet like Tommy Stroud, the Vectorbeam employees who built the machines, the distributors who sold them, the arcade operators who bought them and the technicians that repaired them. Keith Smith, who blogs as *The Golden Age Arcade Historian*, has an unpublished book manuscript on Cinematronics that was put on hold after he was unable to locate several key members of the company. The publication of those interviews would represent a major contribution to the history of Cinematronics and *Warrior*.

As Guins' *Game After* (2014) establishes, the material preservation of early electronic game history has reached a critical point. The struggles to maintain vector monitors in use in *Warrior* and other vector games foreshadow the broader upcoming struggles of the vast majority of games developed for the once-dominant raster-based CRTs. There are still broad lacunae in the larger study of games during this period, with information about managers, operators, assembly workers, and repair personnel mostly uncollected. Similar gaps exist in ethnographic accounts of the arcades and barrooms that hosted early game systems, and the enthusiast press and industry-oriented publications are unevenly archived at best, even at specialist libraries such as the Strong's Brian Sutton-Smith collection. Singular accounts of what happened at the creation of a game are particularly troublesome: as the emergence of Rosenthal's talk demonstrates, history is often written by those who have maintained a connection to the games industry, rather than those with the broadest perspective on the topic. The paratexts of the game industry also have an afterlife, and the material remains of a game production and consumption culture have become increasingly scarce and difficult to find.

Perhaps the public history of *Warrior* is not yet complete. Intrepid collectors, operators and fans might yet bring its hum and ghostly combination of analog and digital forms back to the arcade floor. However, it is difficult to imagine that any amount of fan interest will be able to revive the industrial processes necessary to recreate the constitutive elements of the vector monitor, however. Ultimately, *Warrior* prompts game scholars and fans to consider the mortality of a still-young medium.

Acknowledgments

The author would like to thank the work of the collectors, enthusiasts and scholars who have preserved information about *Warrior*. Furthermore, Dino Manzella, Timothy Shiels, Kevin Steele, the Strong National Museum of Play, Jeremy Saucier, Jon-Paul Dyson, the librarians at the International Center on the History of Electronic Games, Mark Inman, Mike Reynolds of Pinball Pete's, Nick Merrill, Jennifer Light & the Fall 2013 section of History of Information and Communication Technologies at Northwestern University, and MJ Scheer merit special thanks for their assistance in various aspects of researching and revising this manuscript. The anonymous reviewers and editors of *Kinephanos* have also been an indispensable help. I am grateful for their work.

This article is dedicated to my fellow Wildcat, Tim Skelly.

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Thomas H. Rousse studies the interplay of law and technology as a JD/PhD student in the Media, Technology and Society program at Northwestern University in Chicago. While completing an MSc. in Games Analysis at ITU Copenhagen, he collaborated with Glitchnap on LAZA KNITEZ!!, an award-winning local multiplayer game. He moonlights as a cyclist and longswordsman.