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Museum Authorship and the Conservation of Media Installations: Two Case Studies from the Smithsonian American Art Museum

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ABSTRACT
In 2017 and 2018 the Smithsonian American Art Museum (SAAM) engaged in long-term conservation projects for two of its most iconic artworks, *For SAAM* (2007) by Jenny Holzer (b. 1950) and *Megatron/Matrix* (1995) by Nam June Paik (1932–2006). In both works, underlying technologies were replaced due to failure and obsolescence. Contemporary art conservators have developed methods and ethics for evaluating these fraught decisions. Stakeholders designate work-defining properties to establish an artwork's identity, and assess treatments and exhibitions based on whether these properties persist. However, an artwork's identity always has a degree of fluidity and contingency. The culture of the collecting institution and the opinions of those involved influence treatment decisions and the resulting evolution of the artwork and its identity. This paper presents case studies that highlight the creative and authorial roles museum staff play in conserving and exhibiting iterative artworks. Conservators are becoming more comfortable acknowledging the subjective and authorial decisions they make when managing change in artworks. Effective documentation acknowledges these roles and in so doing leaves the door open for future practitioners to reinforce previous decisions or reevaluate them and follow alternative paths.

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KEYWORDS
Jenny Holzer; Nam June Paik; time-based media art; installation art

RÉSUMÉ
En 2017 et 2018, le Smithsonian American Art Museum (SAAM) a entrepris des projets de conservation à long terme pour deux de ses œuvres les plus emblématiques, *For SAAM* (2007) de Jenny Holzer (née en 1950) et *Megatron/Matrix* (1995) de Nam June Paik (1932–2006). Dans ces deux œuvres, les technologies sous-jacentes ont été remplacées à cause de pannes et de l'obsolescence. Les restaurateurs d'art contemporain ont développé des méthodes et une déontologie pour évaluer ces décisions difficiles. Les parties prenantes désignent des propriétés déterminantes pour établir l'identité d'une œuvre, et évaluent les traitements et les expositions en se basant sur la persistance de ces propriétés. Cependant, l'identité d'une œuvre a toujours un certain degré de fluidité et de contingence. La culture des institutions qui collectionnent et les opinions des personnes impliquées influencent les décisions concernant les traitements ainsi que l'évolution de l'œuvre et de son identité qui en découle. Cet article présente des études de cas qui mettent en lumière les rôles créatifs et d'auteur que les équipes de musée jouent dans la conservation et l'exposition d'œuvres itératives. Les restaurateurs reconnaissent de mieux en mieux l'importance des décisions subjectives et d'auteur qu'ils prennent lors de la gestion de changements sur des œuvres. Une documentation efficace confirme ces rôles et, ce faisant, laisse la porte ouverte au renforcement des décisions préexistantes ou à leur réévaluation et au suivi de chemins alternatifs par de futurs praticiens. Traduit par Elsa Thyss.

RESUMO
Os anos de 2017 e 2018 viram o Smithsonian American Art Museum (SAAM) se envolver em projetos de conservação de longo prazo para duas de suas obras mais icônicas, For SAAM (2007) de Jenny Holzer (b.1950) e Megatron/Matrix (1995) por Nam June Paik (1932–2006). Em ambos os trabalhos, as tecnologias subjacentes foram substituídas devido à falha e à obsolescência. Os conservadores da arte contemporânea desenvolveram métodos e ética para avaliar essas decisões difíceis. As partes interessadas designam propriedades que definem o trabalho para estabelecer a identidade de uma obra de arte e avaliam tratamentos e exposições com base na persistência dessas propriedades. No entanto, a identidade de uma obra de arte sempre tem um grau de fluidez e contingência. A cultura da instituição coletora e as opiniões dos envolvidos influenciam as decisões de tratamento e a consequente evolução da obra de arte e sua identidade. Este artigo apresenta estudos de casos que destacam os papéis criativos e autorais que os funcionários do museu desempenham na conservação e exposição de obras iterativas. Os conservadores estão se tornando mais confortáveis reconhecendo as decisões subjetivas e autorais que tomam ao gerenciar a mudança nas obras de arte. A documentação

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eficaz reconhece essas funções e, ao fazê-lo, deixa a porta aberta para futuros profissionais reforçarem decisões anteriores ou reavaliá-las e seguir caminhos alternativos. Traduzido por Beatriz Haspo.

RESUMEN
En 2017 y 2018, el Smithsonian American Art Museum (SAAM) participó en proyectos de conservación a largo plazo para dos de sus obras de arte más emblemáticas, For SAAM (2007) de Jenny Holzer (n. 1950) y Megatron / Matrix (1995) de Nam June Paik (1932–2006). En ambas obras, las tecnologías subyacentes fueron reemplazadas por fallas y obsolescencia. Los conservadores de arte contemporáneo han desarrollado métodos y pautas éticas para evaluar estas difíciles decisiones. Las partes interesadas designan propiedades que definen el trabajo para establecer la identidad de una obra de arte y evalúan los tratamientos y exposiciones en función de si estas propiedades persisten. Sin embargo, la identidad de una obra de arte siempre tiene un grado de fluidez y contingencia. La cultura de la institución colectora y las opiniones de los involucrados influyen en las decisiones de tratamiento y la evolución resultante de la obra de arte y su identidad. Este artículo presenta estudios de caso que destacan los roles creativos y de autor que desempeña el personal del museo en la conservación y exhibición de obras de arte y su identidad. Los conservadores se están sintiendo más cómodos ahora reconociendo las decisiones subjetivas y autorales que toman al gestionar el cambio en las obras de arte. La documentación eficaz reconoce estos roles y al hacerlo deja la puerta abierta para que los futuros profesionales refuercen decisiones anteriores o las reevalúen y sigan caminos alternativos. Traducción: Amparo Rueda.

1. Introduction

A years-long collaborative effort between museum staff, the artist's studio, and the fabrication firm Parallel Development resulted in the de-installation, re-fabrication, and 2018 re-installation of Jenny Holzer's (b. 1950) *For SAAM* (2007). Aging and failure in the 28-foot tall, site-specific sculpture's light-emitting diodes (LEDs) necessitated replacement of the 61,200 diodes as well as the custom hardware and software that animated them. The early 2018 de-installation of Nam June Paik's (1932–2006) video wall *Megatron/Matrix* (1995) prompted months of documentation in order to describe the work's complex behavior, the changes the piece had already undergone, and the potential consequences of any additional technological migrations.

Conservators understand media installations as "dynamic systems" (Laurenson 2004, 49). Normal system behavior over time induces change in the components of that system; meanwhile any changes to the components alter the system behavior. This creates a feedback loop wherein variability is inevitable. Conservators generally encounter the effects of this loop as a material issue. A film projector renders a film print unusable through the accumulation of scratches and tears, and the museum can no longer screen the print. A mechanical element of a sculpture wears down due to friction, and the piece no longer moves as originally designed. When material components break down, like for like replacements are not always available. This is especially true for obsolete technological components. As variability is guaranteed in media installations, navigating treatment decisions has required different outlooks on the impacts of change.

The concept of identity is used to denote the array of acceptable permutations of a variable artwork. It complicates notions of originality, authenticity, and other ethical principles (Laurenson 2008; Hölling 2017, 168). Artworks that exist in multiple iterations are likened to performances. Works lie in a dormant, unrealized state when in storage, and only fully come into being when the dynamic system is enacted, when the piece is turned on, or when the performance is staged. Where originality and authenticity tend to impose strict limits on acceptable changes an artwork can withstand before being damaged or destroyed, identity allows for a broader spectrum of potentially valid representations. There is not a linear continuum between an ideal original state and a state that is damaged beyond repair.

Conservation of dynamic contemporary artworks is no less disciplined as a result. The fact that there are multiple valid ways to present an artwork does not preclude the fact many presentations remain invalid. There is an array of potential choices that artists, curators, conservators, and exhibitors can make when preparing a work for exhibition in a museum. Respectfully uncovering the boundaries of that array demands diligence, research, and care.

While many things can change from one iteration of an artwork to the next, an artwork's identity is a way to name and safeguard those "work-defining properties" of the artwork's system that must persist to the greatest degree possible for a valid iteration. If these properties change substantially enough, damage is done, and the work may be lost (Laurenson 2008).

The concept of work-defining properties exists across several preservation and conservation communities. For instance, digital preservationists generally use the term "significant properties," defined as "those aspects of a digital record that must be preserved over time in order for it to remain accessible and meaningful" (Knight 2008). In this article these terms and others, like "significant behaviors," are used interchangeably, and in reference to a broad array of media. These terms will refer to core properties that must be preserved to allow an artwork to be accessed, used, or exhibited in a similar way as the artist intended, and to convey the meaning of the artwork.

There is no concrete science to designating the work-defining properties that constitute identity (Laurenson 2008). The process is categorically case-by-case. This reality has influenced the many publications that address shifting ethical views in contemporary art conservation. For example, Renée van de Vall states, "There are no principles that apply to all cases; there are many principles that apply to some cases … Principles that are relevant for the case may conflict with each other" (van de Vall 2009). Glenn Wharton echoes the sentiment while highlighting how ethical views reflect local cultural contingencies, "There is clearly a need for broadly accepted professional ethics based on common values, along with more locally developed documents that are specific to geographies, specialisations, artists and media type" (Wharton 2018).

Both articles summarize conservation work on single artists, Joseph Beuys in the van de Vall article and Nam June Paik in Wharton's. Despite the fact that the works came from the same artist, conservation approaches in the cited cases varied substantially. Perhaps the most common strategy conservators use is to refer to the artist's intent to establish work-defining properties. This is a cogent and helpful strategy for many reasons. Luckily in the case of contemporary art the artist is often still alive and able to provide invaluable guidance.

However, artist intent is not a surefire reference point. "Reliance on the artist's authority has often proved to be problematic, for instance in cases where artists wanted to completely remake a work or were no longer able to provide reliable information" (van de Vall 2009). In cases where the artist has passed away it is necessary to interpret past statements in light of new and potentially unexpected circumstances. Whatever strategies are contemplated, the broad directive to adjust one's approach to the case at hand leaves a lot of room for interpretation and negotiation, as those case studies demonstrated. Such interpretation and negotiation is rarely clean cut or self-evident. It will benefit artworks and the conservation field if conservators and other museum staff explicitly address the rationale behind their decisions.

For instance, in the case studies ahead, difficulties in determining the significance of certain properties arose because SAAM staff and other stakeholders understood the artworks in various contexts. One can describe the works as conceptual, software-based, video, media installations, sculptures, among other frameworks. Are they representative of the artist's work or divergent in some meaningful way? Is the original technology merely subservient to more important properties, or is it a work-defining property in its own right? Overlapping ways of thinking about the artworks emphasize different properties as more or less significant. Artistic or curatorial prerogative can change the relative value of properties across iterations of a single work. These issues lead to the conservation problem of navigating differences between multiple iterations, varying stakeholder opinions, changing material conditions, and other factors that delimit the borders of identity. How museum staffs resolve these conflicts depend to some degree on local preferences and external constraints like budgets and available time.

An element of SAAM's institutional mission is to safeguard its collections indefinitely. This task is difficult enough for objects that have relatively stable shelf lives. Artworks incorporating ephemeral components evolve much more quickly and require more frequent intervention. This accelerated temporality of conservation intervention has shone a light on underdiscussed institutional roles.

For instance, conservators require multiple sets of skills. They deploy the research skills of historians, the rigor of scientists, and the delicacy of artists. In addition, many decisions regarding the enactment of iterative artworks emphasize the creative sensibilities of conservators. They imprint the artworks with new meanings in collaboration with artists, their studios or estates, and other collaborators. Museums and their staff do not only maintain artworks and provide access and context, but actively shape the material existence of those artworks and build new contexts. In addition to historians and scientists, museum staff are also authors.

2. Jenny Holzer, *For SAAM*

2.1. Conservation literature

Jenny Holzer's works are held in museums across the world. Despite that, there are not a great number of published conservation case studies of Holzer's LED works. Those that the SAAM conservation department referred to reiterate the central problems faced with *For SAAM*.

On Guggenheim Bilbao's website they provide a summary of their contribution to INCCA's *Inside Installations* project from 2004 to 2007. Silvia Lindner discusses the museum's approach to conserving *Instalación para Bilbao* (1997), a sculpture incorporating nine thirteen-meter tall LED columns, consisting of double-sided steel girders with red and blue LED panels. Lindner writes, "A thorough understanding of the essence of the piece was possible thanks to the identification of the technical elements and aesthetic concepts that the artist deems essential to preserve the integrity of the piece, i.e., those that are immovable and those that are irrelevant and eventually replaceable" (Lindner 2007). Museum staff determined the work's identity, or "essence," through establishing "immovable" work-defining properties with Holzer's guidance.

While the text above comes from a pamphlet for the entire *Inside Installations* project, a more in-depth description of the conservation of *Instalación para Bilbao* was made available through the *Inside Installations* project website. Richard McCoy references this material in an article for *Art 21*, specifically a revealing artist interview. McCoy quotes a helpful passage that provides the artist's instructions on replacing failing components:

> Following artist instructions in case of deterioration of any of the components [in] the piece can be intervened [with] at several levels:
>
> (1) Replacement of any of the original components with equal new pieces.
>
> (2) Replacement of any of the original components with similar new pieces.
>
> (3) In the future if any of the two options above are unfeasible due to the obsolescence of equipments [*sic*] the installation could be adapted to new technologies. (McCoy 2009)

This clearly informed the Guggenheim Bilbao's decisions, as one of the steps they ultimately took was replacing LED panels in the piece (Lindner 2007).

McCoy also discusses his work with Holzer's *Untitled* (1983) at the Indianapolis Museum of Art (IMA). This work is an LED panel with red diodes that displays selections from Holzer's *Truisms*. In 1996 they replaced a motherboard damaged in a power surge with the help of the original manufacturer. In 2000, with the piece malfunctioning and the original manufacturer out of business, IMA worked with Sunrise Systems to fabricate a new iteration (the same fabricators that produced the original iteration of *For SAAM*). The new iteration of *Untitled* had some dimensional differences, for instance being 6½ inches shorter in length, but retained red LEDs and the same programming (McCoy 2009).

Olivier Steib discusses his work at the CAPC Museum of Contemporary Art of the City of Bordeaux with Holzer's *Erlauf* (1998) in a journal article for *CeROArt* (Steib 2018). According to Steib, Holzer's texts have a timeless aspect since they are reused and rearranged throughout Holzer's works. On the other hand, the technology used in a specific artwork allows art historians "to understand when the work is located in the artist's production." Emphasizing the importance of the technology to the work's historical context led the museum to favor certain treatment options over others.

CAPC engaged in rigorous research to ascertain how the technology functioned, including the use of reverse engineering. They also collaborated with the artist and her studio. Steib reveals that CAPC was surprised at how willing the studio was to change the work's technology: "The studio, contrary to our expectations, first advised us to do full replacement, cheaper and more durable" (Steib 2018). CAPC wanted to retain as much of the original technology as possible, and so originally hoped only to replace the diodes. Technical constraints led to a compromise solution, replacing entire LED modules while retaining the original controller and frame.

Steib identifies one area of the treatment with which they were dissatisfied. Due to changes in LED technology and resulting market availability, they had to use "substantially different" blue diodes than those used originally. The artist preferred this replacement as it increased reading clarity and durability, but those at CAPC felt "a certain bitterness that we had to give up before obsolescence" (Steib 2018).

These case studies mirror SAAM's experience with *For SAAM*. The museum staffs obtained a rigorous understanding of the technological underpinnings of the original iteration through investigative means like reverse engineering. They collaborated closely with the artist to aid in research and to consult on possible treatments. Fabricators outside the artist's studio were required for their expertise. Finally, they attempted to find balance between maintaining the artwork's performance and respecting its historical context.

2.2. Background of the work

SAAM commissioned Jenny Holzer to build *For SAAM* for the museum's Lincoln Gallery and she and her team installed the work in late 2007. It is a 28-foot tall, cylindrical, LED sculpture. An array of 61,200 individually programmable bright white LEDs animates a series of the artist's texts, revolving the phrases around the structure (Figure 1).

After approximately ten years of continuous exhibition, technological issues in the piece led SAAM to have the artwork completely re-fabricated. Brooklyn-based firm Parallel Development rebuilt the piece in 2017 and re-installed *For SAAM* in January 2018.

Initially there were three types of components that suffered recurring failures: solder joints, LED segments, and integrated circuits. During that period, replacement of failed components with artist-provided spare parts was an acceptable treatment and maintained the visual aesthetic of the artwork. These treatments were performed by SAAM's former objects conservator Hugh Shockey (Shockey 2008–2015).

In 2014, a new issue surfaced. Replacing LED segments no longer maintained the work's intended appearance. The piece uses phosphor LEDs, which produce white light through the interaction of a blue diode and a yellow phosphor coating. As the LEDs age both elements degrade, and the result is dimming and color shift (Keeping 2012). After 7 years, the LEDs in the piece had been operating long enough to noticeably change. When conservation replaced a malfunctioning segment, the difference in appearance between the new, unused segment and the segments surrounding it was obvious. Patches of brighter, whiter segments were apparent throughout the sculpture.

Figure 1. Jenny Holzer, *For SAAM*, 2008, electronic LED array with white diodes, 853.4 × 121.9 cm.

By 2015, the technical problems had accrued to such an extent that there was significant institutional support for a major conservation project. Informed by an interview with the artist, Shockey originally proposed a treatment that would require producing new PCBs, either to the original specification or with modifications that would ease maintenance, improve durability, and accommodate a change in LED if the original model was no longer available. This reflected Holzer's intent, which primarily focused on the visual properties of the piece (Shockey 2008–2015).

After more discussions between the studio and the museum, re-fabricating the work was decided upon as the best approach. The main rationales for re-fabricating versus rehabilitating the piece as originally built were consistency of presentation, easing maintenance, and the effective use of resources. Maintaining the original technology would likely generate diminishing returns as far as performance, while also guaranteeing the same problems would recur. Both avenues required significant expenditure, so the Smithsonian and the artist favored the path that led to a more stable end result. The artist tied the identity of the work to the visual effect of the piece, a consistent, bright white luminous presentation. This devalued the precise technological components that originally achieved the effect. Newer technology would provide a more durable product and consistent presentation. The redesign would allow the opportunity to obviate some of the maintenance problems the museum routinely faced.

Parallel Development re-designed the hardware to take advantage of advances in LED technology since 2007. While this was an intimidating project, all parties were confident the identity of *For SAAM* would persist in its second iteration through the collaborative effort. The museum was able to pursue this strategy thanks to generous support from the Smithsonian's National Collections Program.

2.3. Technical description of the original iteration

The fabrication company Sunrise Systems designed the original iteration of *For SAAM*. SAAM's former curator of Film and Media Arts, Michael Mansfield, produced a block schematic illustrating the signal flows in the piece (Figure 2).

An HP OmniBook laptop supplied video data to the piece using a DOS executable. The program generated the animations in real time and transmitted the data to the 12 motherboards housed in the collar of the work. The collar, also referred to as the halo, was the topmost structural element in the work. It attached to

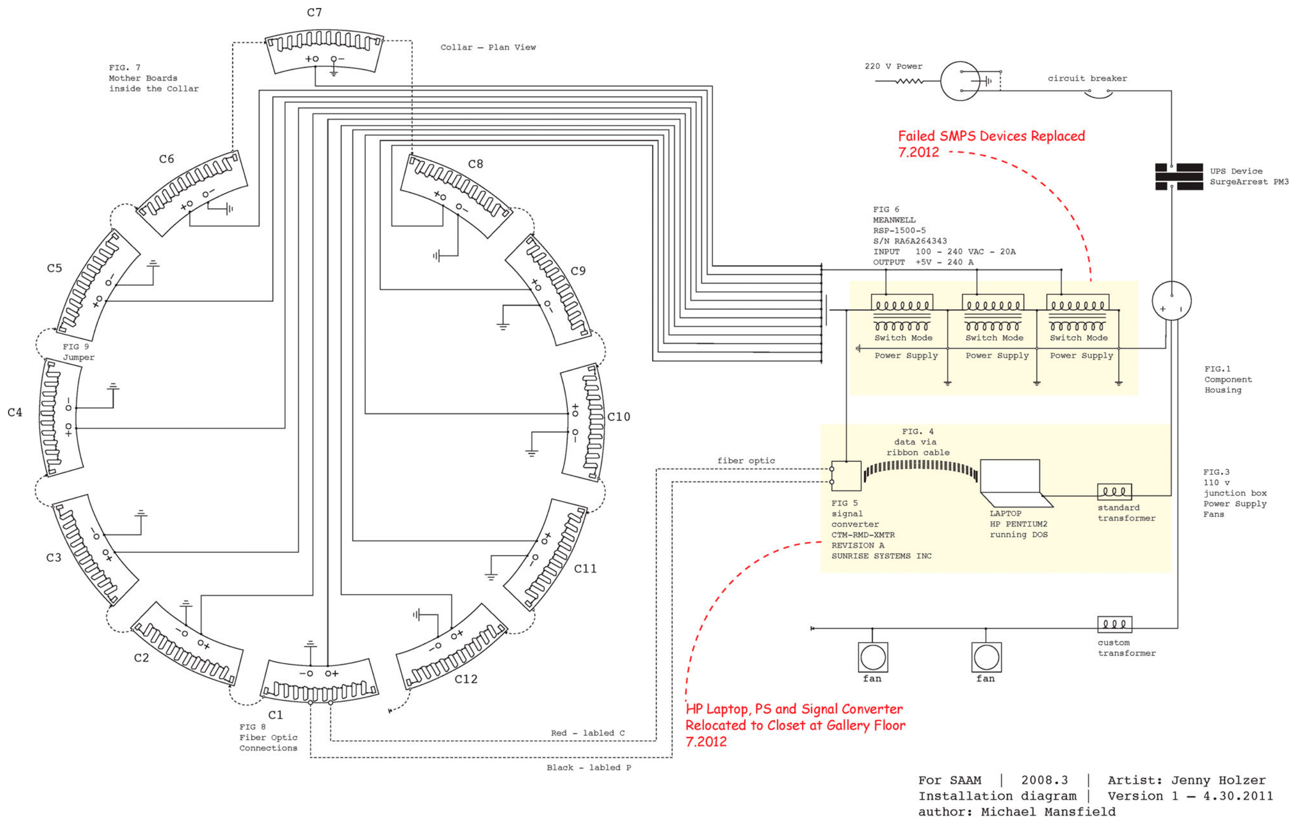

Figure 2. Schematic of *For SAAM*, 2008 iteration, by Michael Mansfield.

a hole in the gallery ceiling, which accommodated the data and power lines.

One can think of the LED array as a large video monitor, with LED diodes playing the role of pixels. The array is comprised of 120 LED strands, with 510 diodes in each strand. The frame size of the monitor is therefore 120 pixels wide by 510 pixels high. Given restraints on the amount of data that the DOS laptop could transmit, and the speed of that transmission, Sunrise Systems transmitted LED diode instructions one strand at a time, as noted by Mohammad Asgari, Parallel Development engineer, in conversation and correspondence on this project in 2019.

Each of the 12 motherboards fed data to 10 strands of LED segments. Data traveled linearly across the motherboards. The motherboard in the first position received the first strand of data, and those LED instructions determined which LEDs in the first strand turned on or remained off. When the next strand transmission arrived, the first strand changed according to the new instructions, while the motherboard carried the data from the first strand over to the second strand, and those the lit up accordingly alongside the new configuration in the first strand. The motherboards copied and moved the strand data this way as new instructions arrived, all the way to the 120th and final strand. This is how the piece generated animation effects, one strand at a time, and always moving in one direction.

Data was also distributed linearly down each LED strand – the topmost LED segment in the strand received all the strand data, it then implemented the instructions for its diodes, and sent the rest of the data through to the segment below, which enacted the relevant instructions on its diodes and sent the remaining data down, all the way to the last segment nearest the ground.

Data passed vertically between the LED segments via the solder joints. Therefore, when these joints suffered problems, the segments below ceased to receive any data. The visual signal of this issue was a strand with LEDs either always on or always off below the effected segment (Figure 3). The solder joints provided structural support and data transmission, making them vulnerable to damage.

2.4. Retaining identity through technological migration

Most of the hardware changes were assessed according to observable work-defining properties. The piece had to maintain the same overall physical dimensions, and

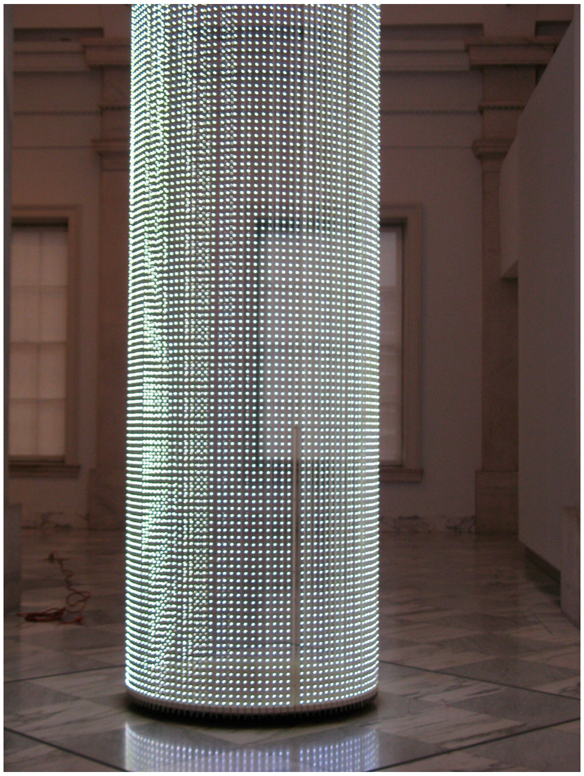

Figure 3. View of malfunctioning LED segment in *For SAAM*. One segment's malfunction shuts off data flow to all subsequent segments.

to this end the original halo and base were re-used. These were the only components from the original piece to remain.

Other changes to hardware included new LED diodes, new LED boards, new motherboards, and a new computer. The same number of strands, the same number of diodes, the same spacing between the diodes, the same viewing angles for the diodes, and other observable physical characteristics remained, within tolerances deemed acceptable by SAAM, the artist, and the fabricators.

The connections between the LED segments changed from solder connections to conductive screw plates (Figure 4). This change allows for easier maintenance. With the original work, replacing a malfunctioning segment required the conservation department (Shockey and conservation technician Susan Edwards) to remove the entire 28-foot strand from the piece and lay it flat on the gallery floor. They de-soldered the connections to the suspected problem segment, then soldered in the replacement. Next, they reconnected the entire strand and turned on the piece to verify the treatment was successful. With the new screw plates the strand can remain in place, and a new tool allows the present conservator to remove the problem segment while maintaining tension across the strand. This greatly reduces the amount of time needed to perform the task and reduces additional strain on the surrounding segments.

2.5. Animation source as work-defining property

At one point, both the artist's studio and Parallel Development suggested changing the underlying content source so that the animated text originated from pre-rendered video files instead of a script generating the content in real time. Many contemporary LED arrays produce their content with pre-rendered files, and the professional opinion of Holzer's studio and Parallel Development via personal communication in 2019 was that this method produces more reliable results.

SAAM had to determine whether the animation source was a work-defining property. An important note here is that though the original software was generative, it was never random. The order, fonts, and movements of the text animations were scripted to be the same every time. Therefore, one concern was abated, the method would not in theory produce a significantly different visual result. The observable work-defining properties would persist. The chief issue then was whether this technology was a significant property in and of itself. Does the identity of *For SAAM* require this "software-based" component?

Initially, the author and curator Michael Mansfield were in the camp that this property was defining. Mansfield summarized the position well in an April 2017 e-mail to the author, "The artwork is not 'video' playing on an elaborate display, but rather an eloquent presentation of both social and binary codes … Video has its own history and modes of production as an art form. Software systems and computer-generated art are something different." The nature of the performance of the animated messages in the display informed the institutional interpretation of the artwork as a software-based artwork. Much like Steib described with *Erlauf*, SAAM staff felt the property tied the work to a specific historical context.

However, in her communications with the museum, Holzer made clear she always conceived of the piece operating primarily as conceptual art and sculpture – not as software-based art. For her, the programming, which she painstakingly oversaw but did not personally create, plays a largely functional role. Her conception of the work's identity is not located in the coding or hardware decisions that achieved the work. Changing or eliminating parts of the original programming would not erase signs of the artist's hand.

Based on the artist's input and the lack of meaningful impact the change would have on the observable behavior of the piece, eventually SAAM agreed to the switch

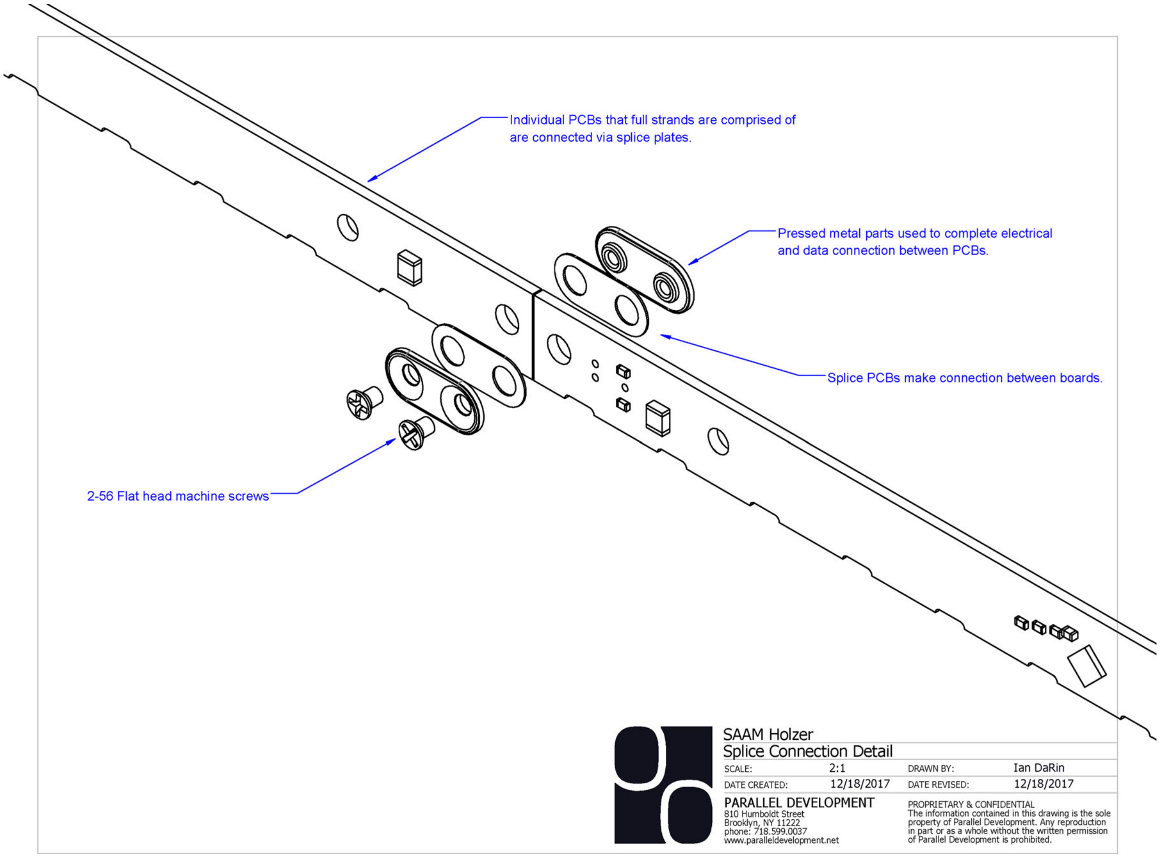

Figure 4. Parallel Development's redesign of the LED segment connection, allowing for easier maintenance.

to pre-rendered video files. SAAM staff decided that they had inferred a context that the artist had never intended.

Once the museum agreed to change the source, the author began writing a narrative report explaining the rationale behind the decision. That report formed the basis for this case study and contains a lot of the same information. It is in essay form and includes a departmental treatment history, a description of the technical properties of the original, a description of the concept of work-defining properties and why SAAM staff originally identified the animation source as a work-defining property. There is a summary of key correspondences between SAAM, Holzer's studio, and Parallel Development. Finally, there is a description of how SAAM staff ultimately became convinced that the change was in fact an acceptable treatment that respected the identity of the piece.

Ultimately, it all became a moot point. Other technical constraints required using the original generative methodology. Neither the studio nor Parallel Development were able to reliably reproduce the same fonts and typefaces that the original DOS program used, as Asgari detailed in personal communication to the author. The theoretical proposition that the observable behavior would remain unaltered evaporated, and so using pre-rendered files was no longer an appropriate solution.

Once the change was deemed inappropriate, the author updated the narrative report. It was updated throughout the rest of the project to describe subsequent decisions and who made them. Now the report serves as a history of the institution's shifting opinions on the identity of the work during the re-fabrication project. The report has significant value as a document of institutional knowledge and as a reference point for future decisions regarding the work's technology.

2.6. Inevitable change

The museum had collected source code files from Sunrise Systems for the custom DOS software, but they were so reliant on the original hardware that Parallel Development deemed migration an unfeasible route forward. The alternative was reverse engineering the signal the original laptop sent to the piece.

Mohammad Asgari and Will Pickering of Parallel Development used a Pico Technology PicoScope 2208B MSO logic analyzer to plot the signal coming off the laptop, constituted by two data streams,

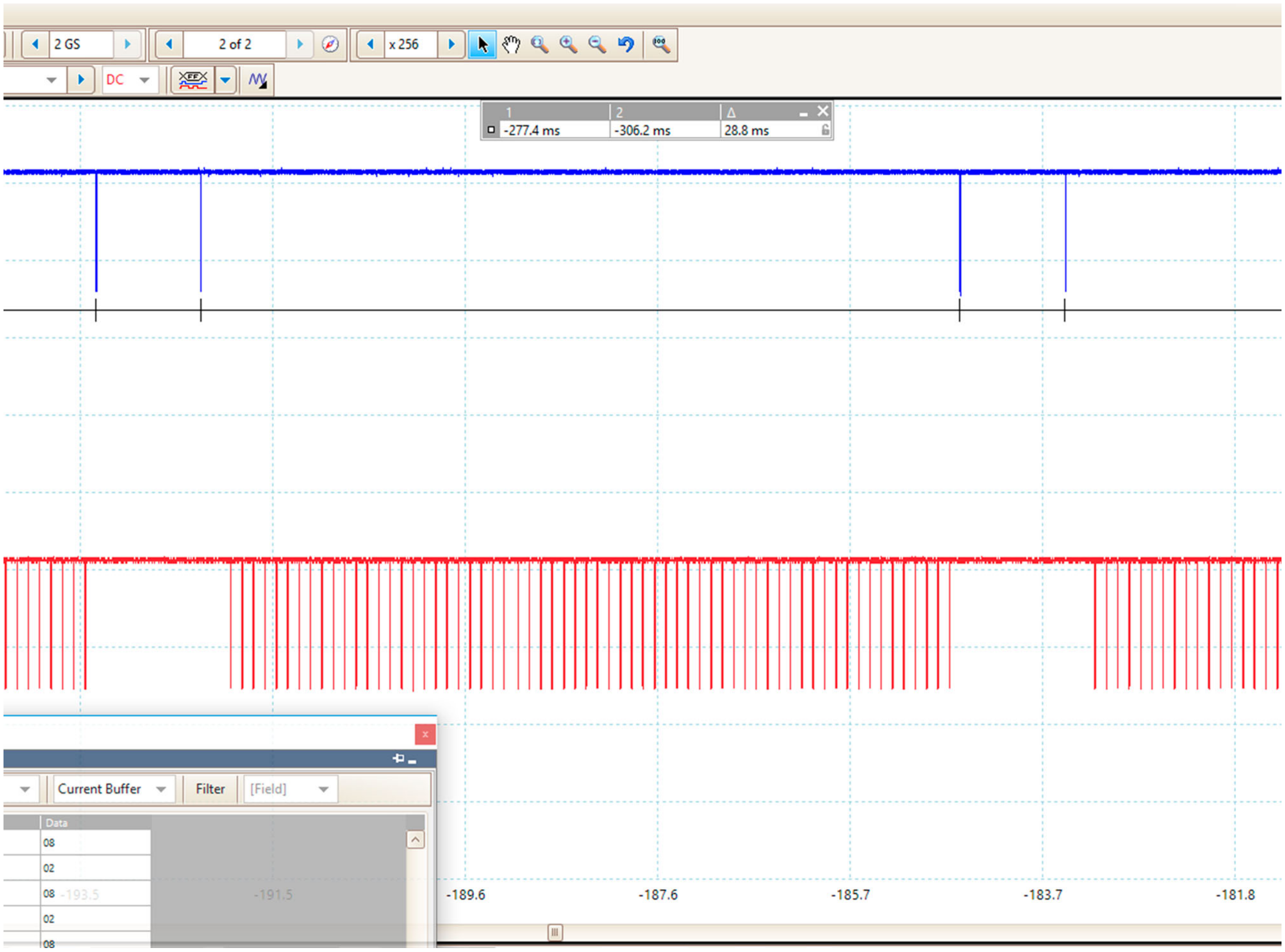

Figure 5. Output from logic analyzer, view shows data pulses encoding instructions for one strand of data.

"command" and "data" (Figure 5). The graph helped them uncover the rules governing the data transmissions. "Command" data pulses, the top line in Figure 5, signaled the beginning and end of "data" pulses, shown in the bottom line of Figure 5. Each set of "data" pulses contained instructions for one strand of LED lights, determining an on or off state for each diode in the strand. The custom hardware in the piece took care of shifting previous instructions to subsequent strands as new instructions arrived. Strand instructions keep shifting until they reach the final strand and are effectively forgotten by the hardware. With the programming logic understood, Parallel Development enlisted developer Jason Cipriani to develop the software for the new iteration.

Whether through migration, reverse engineering, emulation, or a new content-generation process altogether, the underlying instructions governing the animations were inevitably going to change to some degree. Many properties of the piece changed between the two iterations. SAAM, the Holzer studio, and Parallel Development navigated practical limitations, material changes, observable changes, and conceptual consequences to select the path forward that seemed to best maintain the identity of the piece. The conservator strived to accurately capture these decision-making processes in the narrative report.

These decisions highlight the creative role institutions play when conserving a media installation, or any artwork that exists in multiple iterations. The relationship between conservator and artist studio is not merely to transcribe instructions. It often permits and even demands active collaboration and negotiation to determine an artwork's identity. These negotiations occur in good faith. Neither party will likely seek to radically change the identity of an artwork. Rather, differences in opinion stem quite naturally from differing conceptual frameworks surrounding that identity. The Holzer studio inquired early on about creating new content for the sculpture. As SAAM's chief goal was to maintain the work as it was acquired in 2008, this was ultimately determined by the parties to be out of scope of the project at hand. SAAM therefore has shaped the evolution of the piece by temporarily negating a potential change. The idea has not been dismissed outright though, and the possibility of new content remains. Pursuing new content would obviously create all sorts of new challenges for the museum and artist studio to navigate; perhaps material for a future study.

The new iteration of *For SAAM* dealt with most of the technical issues that impaired the original iteration. Only one major technical concern remained, which was how SAAM should avoid the same brightness mismatch issue after years of regular exhibition that became so problematic in the original iteration.

To that end, SAAM collaborated again with Holzer's studio, Parallel Development, and the National Collections Program to build a spare aging system. The system was installed in late 2019 outside of the museum's Lunder Conservation Center visible conservation labs. It runs spares at a rate tuned closely to the piece, so that when needed, spares will match the color and brightness of the segments in the artwork, even after years of use. The corridor where the system is installed serves as a pedagogical tool for the public to learn more about Jenny Holzer's work and time-based media conservation.

Another important shift in how the museum maintains the work regards the power on and off schedule. The original iteration was left on at all times, 24 h a day. The current iteration is turned on every morning a half-hour before museum opening and turned off a half-hour after closing, or as needed for special events. In general, rapid power cycling is bad for electronics. Discussions between the Holzer studio, Parallel Development, Smithsonian facility electricians, and SAAM staff in this case led to the conclusion that the system could withstand daily power cycling and the benefit to the useful life of the LEDs would be substantial.

It is important to note that these two projects, the refabrication effort and the implementation of a spare aging system, required significant investments of Smithsonian funding and staff time. All of that effort was unanticipated and unplanned for at the time of acquisition. Institutions must learn from the more rapid evolution of art works incorporating ephemeral media. Long-term budget plans should take into account the distinct possibility that portions or the entirety of an artwork may need replacement or reconstruction within a relatively short amount of time. This can be difficult to forecast for obvious reasons. A good place to start is by using the original fabrication costs and labor hours. One should attempt to estimate how often the piece might need serious interventions. The cost of those interventions could be given as some percentage of the original costs. In the current case the museum is hopeful that the useful life of the new iteration lasts longer than the original given the improvements in LED technology. Museum staff is therefore advising that in 10–20 years additional investments may be required to maintain the work.

This increased rate of change highlights the creative role institutional staff perform. Conservators should adopt documentation methods that acknowledge the institution's creative role and allow for future reinforcement or reinterpretation of past decisions.

3. Nam June Paik, *Megatron/Matrix* (1995)

3.1. Conservation literature

There is a rich conservation literature surrounding the works of Nam June Paik, representing a large number of conservation approaches. The author must only scratch the surface here.

Joanna Phillips began her presentation at SAAM's 2013 symposium *Conserving and Exhibiting the Works of Nam June Paik* by noting that conservators seem particularly drawn to "the intriguing contrast between Paik's own very flexible approach to the notions of originality and authorship [as an artist and conservation adviser] and the fact that the majority of his works are not very flexible at all when it comes to migration because they are so inherently and conceptually analog" (Phillips 2013a). In that presentation, Phillips addressed a number of Paik installations in the Guggenheim's collection, including *Random Access* (1969/99) and *TV Crown I* (1965/98–99). Though very different works, Phillips explained how in each Paik's explicit interventions with the inner workings of the chosen media, open reel audio tape players in *Random Access* and cathode-ray tube (CRT) televisions in *TV Crown I*, rendered the possibility of migration inconceivable without abandoning work-defining properties and greatly damaging the works.

As one example, the imagery on the television in *TV Crown I* was not derived from videotape or a live broadcast, as would normally have been the case when watching a television in 1965. Instead Paik used the mechanism of the television itself to generate imagery. In CRT televisions electron guns fire electrons at phosphors on the screen which are then excited by the presence of charge and illuminate. Usually the electron gun's movement is guided by a signal coming from a broadcast or videotape, and that signal manipulates the electron gun in such a way that the excited phosphors produce intelligible images. Paik rewired his television such that a viewer of the installation could manipulate its imagery using audio frequency generators and amplifiers. The audio signal replaced the signal the television normally interprets. This innovative modification is highly resistant to being migrated to other television technologies like LCD. Newer televisions work completely differently. Phillips justifiably concluded the work is highly inflexible due to its analog character (Phillips 2013a).

Glenn Wharton's "Bespoke Ethics and Moral Casuistry in the Conservation of Contemporary Art" is an excellent introduction to the variety of ways contemporary art conservators have grappled with treating Paik's pieces (Wharton 2018). Wharton summarizes recent Paik conservation case studies and evaluates the decision-making according to ethical guidelines proposed by Renée van de Vall and Joseph Ashley-Smith. He addresses how the conservators' rationales in each case stemmed from the specifics of the artwork as well as their institutional cultures.

One case where museum staff determined there to be more flexibility than in the example of *TV Crown I* is work performed at SAAM on one of Paik's robot sculptures, *Untitled* (1992). CRT monitors in the sculpture no longer functioned. Former objects conservator Hugh Shockey replaced the interior electronics with a flat screen television. While there is a change in the appearance due to the new screen, retaining the original monitor chassis retains a significant amount of the sculptural character. The change also reduces the burden on other load-bearing components in the piece (Mansfield and Shockey 2013). Here a negotiation of various priorities led to a treatment that takes a more flexible approach to change, in part due to the way CRTs are specifically deployed in this context.

Hanna Hölling's book *Paik's Virtual Archive* is an excellent resource that gathers an incredible amount of pertinent information about the history of Paik's work and its conservation (Hölling 2017). Throughout the book one finds examples of treatment strategies that were deemed unacceptable for one work but justified and implemented in a different case.

She asserts that the archive serves as the foundation for the identity of an artwork between and across separate iterations. All the documentation around an artwork including conservation treatment reports, installation diagrams, curatorial writings, artist interviews, letters, etc., together provide a holistic account of the artwork's meaning and evolution over time. Conservators and museum staff contribute to an artwork as it evolves by contributing to the work's archive.

Across all these studies, conservation departments first and foremost seek to understand the particularities of a given work. Only then do they attempt to evaluate treatments and their consequences. The specific situation helps shape the ethical principles used to guide treatment, tempered by the predilections and creative efforts of the staff involved.

3.2. Basic description of the work

Megatron/Matrix is a monumental video wall consisting of two side-by-side arrays, displaying ten channels of video accompanied by stereo audio. The arrays are "Megatron," a 150-monitor array arranged in a stack ten monitors high by fifteen across, and "Matrix," a 65-monitor configuration made up of four 4×4 arrays with a single monitor anchored in the middle (Figure 6). There is a total of 215 CRT monitors in the piece; 214 of the monitors in the piece are 19″ and a single 13″ monitor is used for the central monitor in the Matrix array.

There are two video processing systems, one for each array. The systems process and distribute the available video signals. As both systems make use of custom video processing hardware, there is significant risk of information loss should this equipment fail. Precisely describing their behaviors was the primary goal of the documentation effort leading up to de-installation.

As installed in SAAM, power transformers converted power from the North American standard to the South Korean standard the Samsung CRTs use. A dedicated breaker was used in the room, and the piece used 30 power receptacles across 12,220 V circuits and 6110 V circuits. The video wall was assembled using custom metal chassis covering the Samsung CRTs. The chassis were attached together using screws and bolts, and the entire video array was secured to the rear gallery wall using metal wires. There were two wooden elements, a base underneath the bottom row of televisions and a catwalk behind the arrays. The catwalk provided access to the rear of the upper rows of televisions, and also assisted with cable management. Exhaust fans behind the wall mitigated heat.

SAAM de-installed the work in March 2018 after 12 years of exhibition. Before de-installation, staff worked for months documenting the significant behaviors of the artwork in order to have a reference in the event of hardware failure when SAAM next attempts to exhibit the piece. The conservation department envisioned this reference information as a tool for future migration, if the museum deems such a treatment option necessary and appropriate. As one of the most technically complex works of Paik's career, it bears ample consideration whether and to what extent migration adversely affects the identity of *Megatron/Matrix*. At the same time, several elements of the piece have already been migrated to

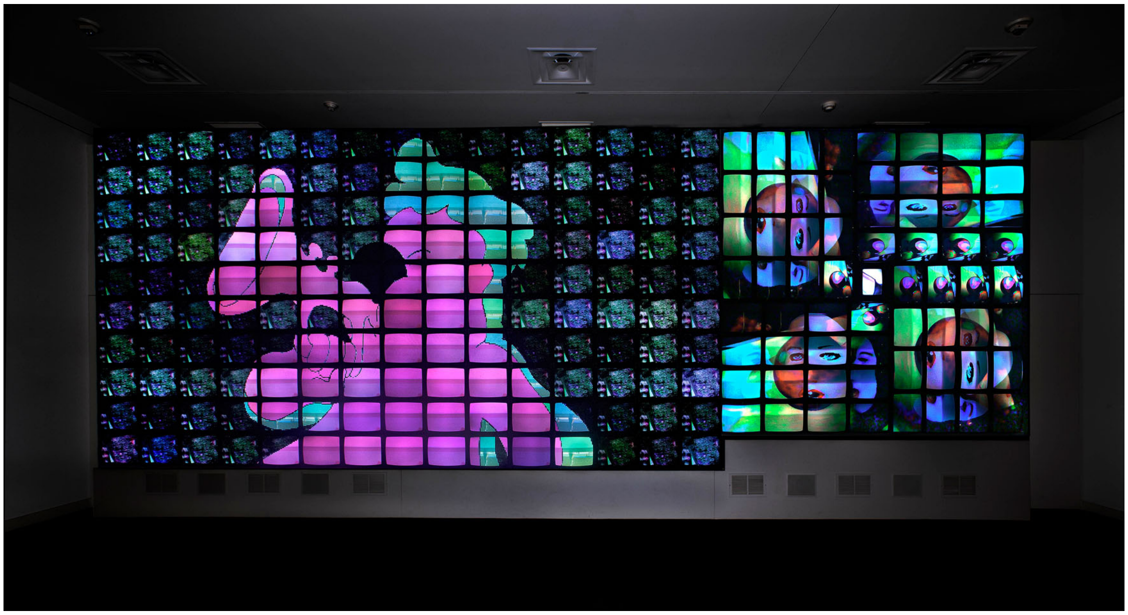

Figure 6. Nam June Paik, *Megatron/Matrix*, 1995, eight-channel video installation with custom electronics; color, sound, approx. 335.3 × 1005.8 × 121.9 cm.

new technologies. Ultimately, conservation staff decided it was optimal to document the behaviors as precisely as possible to allow for migration to remain an option for the future, and to provide a more comprehensive technical description and treatment history of the artwork than yet existed.

3.3. Video sources

The ten video signals in the piece include animations originating from a PC, a reference black video signal originating from the Megatron processing system, and eight channels of video from standalone players. The eight channels of video content were originally LaserDiscs. SAAM migrated the LaserDisc channels to DVD in 2007, and then migrated the DVDs to digital files in 2011. In every case video was fed to the Megatron and Matrix processing systems as composite signals. As part of the documentation process, the conservation department generated digital preservation files from the LaserDisc copies, as the DVD encoding process introduced compression that noticeably affected image quality. In general, contemporary conservators are quite comfortable with the migration of video content from one format to another, and it is especially well-documented in the case of Nam June Paik's works (Hölling 2017).

Of the standalone players, channels 1, 2, 3, 4, 5, and 8 go directly to the Megatron processing system. Channel 4 contains the stereo audio distributed to two speakers. A Kramer distribution amplifier duplicates Channel 6 and sends that signal to both arrays. It is the only channel used in both. The signal path for Channel 7 is the simplest to describe. The Channel 7 player connects directly to the central 13″ CRT in the Matrix array. The animations and reference signal appear only in the Megatron array.

3.4. Video processing

Paik enlisted video engineer and frequent collaborator Jung Sung Lee and his company Art Master to design and build the processing hardware in both arrays. The key behavior across all the processing is rasterization, also known as spanning or mapping. All these terms carry multiple meanings in image processing, but in this article, they should be read as the ability to spread a single video signal across multiple monitors. All the programming in this piece plays with this ability in some way. Each processing system determines the precise behavior differently, so each array presents different challenges.

The Matrix array has three components that achieve its effects. First, a time-base corrector (TBC) stabilizes a single channel of video. The TBC sends the stabilized video signal to a processor that produces a raster for 16 monitors arranged in a 4 × 4 array. That device sends the rasterized 16 outputs to a third processor. The third processor quadruples the outputs so that the rasterized signal can feed four separate 16-monitor arrays. It is also a sequencer, and it sequences an animation across all its 64 outputs by commanding each monitor either to show its portion of the rasterized signal (i.e., one sixteenth of the total image), or to show the complete signal. Figure 6 provides an illustration of this process. Matrix is the array on the right-hand side, and six monitors on its right are showing the complete signal, while most remain showing their portion of the 4 × 4 raster.

The Megatron processing system is now on its second iteration. SAAM commissioned Mr. Lee to build the second iteration in 2011, and stipulated ample documentation as one of the deliverables. Mr. Lee provided a user manual that includes operating instructions, troubleshooting procedures, block diagrams, and schematic design drawings for all components. That exhaustive level of documentation unfortunately does not exist for the Matrix hardware.

A large rack unit, roughly the size of a refrigerator, houses the twenty-one components that govern the Megatron array's complex behaviors. PC animations are rasterized and distributed across the entire array. The system takes the video signals sent from the standalone players and overlays those signals on top of the rasterized animations according to instructions encoded in the PC animations themselves. Decoding this editing logic has been the most challenging part of documenting the piece, and those ongoing efforts are discussed in more detail below.

3.5. Documenting the Matrix array

The Matrix array's sequencer follows a specific, repeating sequence. There was no external record of the sequence; nothing that detailed how the monitors displayed what form of the video signal and when.

Given conservation staff's lack of electrical engineering experience and the uniqueness of the hardware, opening the piece up and attempting to locate and analyze the component that might have stored this sequence data was not a desirable option. Moreover, it was unknown whether any extractable data would be sufficiently human-readable to allow for describing the sequence, much less re-programming the sequence for new technology.

The pertinent question then was how to generate a description of the hardware's behavior that could exist independently of the hardware itself. Luckily, the sequencer has two modes of operation, play and step. The play mode is how the piece normally operates. It runs through the entire sequence on repeat. In step mode, the user can advance the sequence one step at a time. The sequence does not advance until the user presses a button. This feature was integral to generating hardware-independent documentation.

Conservation set up a camera and photographed each step of the sequence. To make the photography more legible, a crosshatch test signal replaced the normal video content (Figure 7). A monitor showing a widely spaced grid would signify the raster state (showing only one sixteenth of the image), while a dense grid would signify the whole image state (showing the entire crosshatch test signal). One person operated the camera, a second operated the sequencer, and a third served as intermediary communication – the piece's network of exhaust fans was quite loud. It took two workdays to capture the 4343 steps in the sequence. SAAM now has a way of explaining the intricate behavior independently of the hardware. Labeling the image files to maintain correct order and capturing the framerate ought to provide sufficient information to assess subsequent iterations' behavior. It would take considerable effort to rebuild the sequencing functionality with new equipment using this documentation, but it is at least possible now.

3.6. Documenting the Megatron array

A similar documentation problem exists with the Megatron array. Thanks to the provided schematics and

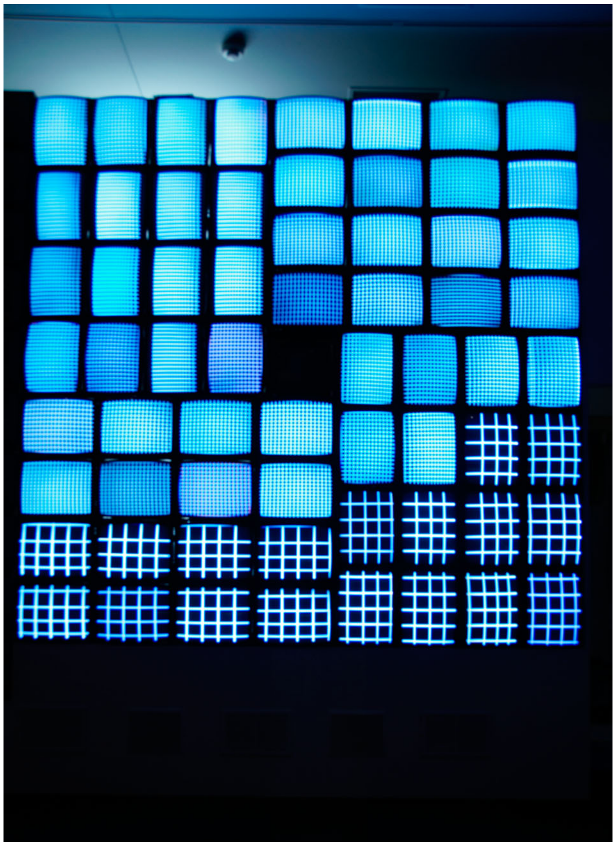

Figure 7. Matrix array with substitute crosshatch signal.

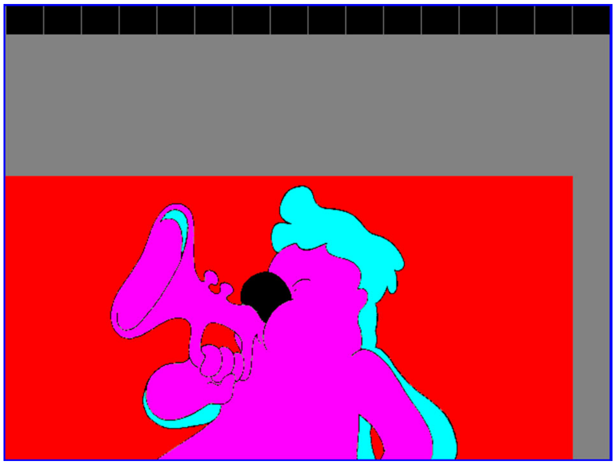

Figure 8. Still from Megatron array PC animation.

additional correspondence with Mr. Lee, SAAM has a solid grasp of the information flow in the work. However, as with the Matrix array, there is no clear external record of the precise logic that determines a crucial behavior. Conservation wanted to describe this behavior exactly.

The PC animations contain embedded instructions for the system. Figure 8 shows a still from the animation that is displayed by the Megatron array in Figure 6. Figure 8 shows the animation prior to any processing. The row of squares at the top of the image is how Mr. Lee encoded the display instructions, as noted in March 2018 correspondence with Lee. The squares and empty space around the animation are removed from by the time it is displayed in the array. The squares are encoded instructions. As animations progress, some squares are white, some black, and the sequence changes over time. Once interpreted, this sequence of squares instructs the system how to overlay the video content on top of the piece. In Figure 6, one of the channels of video replaces the background of the animation as depicted in Figure 8.

All the PC animations were made using eight colors; black, white, red, green, blue, cyan, magenta, and yellow. There is a corresponding number of video signals the Megatron system can choose from; a reference black signal generated by the Megatron system, and seven channels of video from the standalone media players. Each square sequence tells the system which specific colors, if any, to replace with which specific video channels. There are backups of the animation files, so an independent record of this behavior already exists. It just needs to be decoded in order to be useful for any potential migration project.

As part of the Megatron processing system, one can monitor the PC animations prior to processing. The order of animations is scripted and repeats over time. Conservation recorded video of the PC monitor while the piece ran, as well as video of the array from the audience's perspective. These two views will assist the conservation department in decoding the instructions. This research is still ongoing.

3.7. Ongoing efforts

The first task in determining appropriate conservation treatments is achieving a rigorous understanding of a work's technical properties. The SAAM conservation department's documentation efforts comprised an attempt to attain a rigorous understanding of *Megatron/Matrix*. Developing hardware-independent documentation of the video processing logic has greatly improved the museum's technical understanding of the work. SAAM can now develop a "score" of the editing decisions the processing systems make. The hardware-independent documentation enables migration since it provides a behavioral reference point that is easier to preserve and access. It will still be up to staff to determine if migration is an appropriate route to take.

As yet, the work has not been re-installed and has not required additional treatment. As a result of the new documentation, staff can now draw more effective comparisons with other cases. Migrating the custom video processing hardware to a new system now seems like an acceptable option. There is a precedent in the history of the work. The technology seems more functional than a distinct property in and of itself. The innovative overlay of various video channels on top of an animation raster seems to be the chief effect of this property and achieving it by another means does not appear to be out of the question. In *Random Access* and *TV Crown I*, the underlying technology is exposed and modified, becoming an inextricable feature of the work. In this case there is not the same sculptural and aesthetic value assigned to the underlying processing system, as ingenious as it is.

It is more difficult to imagine shifting away from CRT technology, given that the CRT monitor is the basic sculptural unit of the array. Using flat screen monitors with 16:9 ratios would drastically change the feel of the piece. Perhaps seeking a similar solution as Shockey implemented in the robot *Untitled* would be acceptable, as it would maintain the basic sculptural dimensions of the CRTs. Finding flat screen TVs in the correct aspect ratio is getting more difficult unfortunately.

Maintaining the current CRTs as long as possible is crucial. SAAM power cycled the installation daily, which falls within the prescribed guidelines from Dan Meijer, an electrician and former Smithsonian employee who has worked on countless CRTs for *Megatron/Matrix* and other media works at SAAM and across the whole of the Smithsonian. In some cases, he has recommended leaving CRTs on indefinitely for an entire exhibition. The museum is also investigating whether the work can be installed in storage in order to periodically run the CRTs. Like cars, complex installations can degrade just as easily if they are underused as when they are overused.

There is a promising new development regarding the lifespan of CRTs. In "Revisiting the Decision-Making Model for the Conservation of Contemporary Art," Giebeler et al present a case study of Paik's *Fish Flies on Sky* (1985/1995) to illustrate their powerful model. With the help of engineers who have rediscovered an old CRT repair technique, they were able to rebuild the tubes of the CRTs in the piece, repair the electronics, and extend the monitors' life expectancies by as much as 35 years (Giebeler et al. 2019, 18). SAAM has been investigating this possibility for its Paik artworks and will continue to work towards this goal.

Unlike with *For SAAM* and Jenny Holzer, the museum can no longer ask Nam June Paik himself for guidance on future conservation treatments. If staff seeks additional counsel on the artist's intent, it must refer to extant documentation or ask those who collaborated with Paik. As time progresses artist intent will become increasingly filtered through the subjectivities of additional stakeholders. This highlights why conservators' roles take on authorial elements. As the collecting institution, the ultimate authority for managing this work's identity rests with SAAM.

4. Conclusion

How artists and collecting institutions establish work-defining properties will influence what conservation treatment options seem appropriate. Therefore, documenting the rationale behind these designations is just as important as documenting the properties themselves.

Technical properties can be easier to objectively assess and evaluate across iterations than more conceptual properties. Something relatively simple like the aspect ratio of a video image, or even complex like the Megatron array's animation overlay decisions, should be able to be assessed with the aid of creative and thorough documentation.

If the use of a specific technology is a work-defining property, then this is easy to evaluate – either the work uses that technology, or it does not. However, the property is thereby impossible to preserve indefinitely (Laurenson 2004). Ideally the original technology is maintained as long as possible, but nothing lasts forever.

Assessments on the value of technological components need to be revisited over time. Technological changes can shift the significance of specific equipment, once new technology no longer allows for behaviors that were once taken for granted (Phillips 2013b). Institutions ideally become aware of work-defining properties based on specific technologies before acquisition, so they can either avoid collecting artworks they cannot exhibit indefinitely or make plans on how to accommodate the artwork's "death" as an anticipated event in the collection lifecycle. In the latter case one strategy would be to display documentation of the artwork and present it explicitly as documentation, like video recordings of performance art pieces.

Conceptual properties are inherently more subjective. Differences in opinion arise often between various stakeholders, especially if works are sufficiently complex. For instance, determining whether the underlying video source in *For SAAM* was in itself a work-defining property.

There are many elements to consider when approaching the ongoing treatment and maintenance of iterative artworks, and each work will demand its own solutions. Fortunately, there are guidelines available, if not hard standards. The aforementioned decision-making model for contemporary art conservation lays out a comprehensive schema to assist institutions in identifying stakeholders, weighing potential treatments and their consequences, and explicitly stating stakeholder rationales (Giebeler et al. 2019). In the case of *For SAAM*, a narrative report structure was used to gather stakeholder decisions, rationales, and expositive context. Moving forward, the author will use the revised decision-making model for the conservation of contemporary art to structure such reports.

Working with living artists is a tremendous asset when establishing artworks' identities. Any primary documentation conservators and artists generate will naturally have enduring value. Nevertheless, in future generations, when the artist's voice is locked in the past, institutions will need to have developed a degree of self-sufficiency when evaluating changes between artwork iterations. They may respond to new technological opportunities in ways that emphasize their own curatorial or exhibition prerogatives, and these perspectives about the fundamental meanings of the artwork will shape the work's continuing conceptual and material evolution, well outside the artist's direct sphere of influence.

Time-based media works' iterations can have very short life cycles, built as they are on complex and layered systems of ephemeral media. As a result, the evolving opinions of curators, conservators, and other institutional staff will not only change the way people understand and talk about these artworks but will also have direct impacts on their physical existence.

Such evolutionary shifts are a direct consequence of the act of acquisition. Although institutions strive to create, sustain, and provide historical context along with the artworks themselves, acquisition is also a guarantee that the institution will usher objects out of their original place and time and into unknown and unimaginable future contexts (Hölling 2017, 143). Museums must acknowledge this productive role. Taking over the physical ownership of evolving artworks means taking ownership of the evolution itself. The role is one of stewardship, but also authorship.

An acquired artwork's identity is not fixed, and it is developed by many contributors over the work's life. It is therefore crucial not only to document physical changes to artworks, but also to record all the rationales for treatment decisions and any practical limitations imposed upon the decision-makers. Museums must make their institutional authorship explicit in order to guide the evolving identity of the artworks in their care ethically, ensuring identities remain grounded in the most appropriate work-defining properties.

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