Notation for an Electric Stage: Twenty Years of Writing about Notation and a Thought Experiment
With additional commentary about Preservation*

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1. Introduction

The first conference paper I ever wrote was a survey of electro-acoustic composers' thoughts on notation published in the proceedings of the 1999 International Computer Music Conference[1]. As a Master student in computer music composition at Peabody Conservatory nearly twenty years ago, I was already aware that notation for interactive music was problematic, and I continue to struggle with notation, particularly notation of interaction and timbre as a composer / performer / author and professor of electronic music. This paper covers my history with notation, and ends with a thought experiment about notating László Moholy-Nagy's Light Prop for an Electric Stage.

2. Background

Unlike most composers my age, my first compositions were for electronic sound sources. I was fortunate enough to attend a summer program in computer music at Oberlin College when I was sixteen, and my first composition was written there – a piece for cello and tape, *The Persistence of Memory* (1990). Even then I wanted to notate the tape part, and my instructors showed me Rainer Wehinger's gorgeous score for Ligeti's *Artikulation* (1958). I attempted some cursory graphic notation but got very frustrated with my own drawing ability (and didn't think to use MacPaint) and instead simply notated the cello part in Finale. I ended up drawing several cues for the tape part for myself on the printed score. Years later I started a project of looking at performers' marginalia in the Peabody library's copies of Davidovsky's *Synchronisms* – theorizing that as his notation of the electronics became more detailed, the number

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* Margaret Schedel is the author of Sections 1-3 and 5; Federica Bressan is the author of Section 4.

[1] Schedel, Margaret, "The Notation of Interactive Music: Limitations and Solutions", *Proceedings of the 1999 International Computer Music Confernece*, 1999, pp. 403-406.

of penciled in markings would decrease. Unfortunately it was very difficult to read the erased markings, and the flute *Synchronism* had been checked out (and I assume performed) many more times than the other works combined, so I abandoned the project. I knew I wanted to study the notation of electronic music, so I decided to send out a survey to computer music composers. While I worked on that paper I had the great honour to speak to both Mario Davidovsky and Pierre Boulez about notation at the 1998 Society of Composers in New London, Connecticut.

At the time I also became obsessed with John Cage's 1969 book *Notations*[2], and was desperately searching used book catalogues online trying to find my own copy but they were going for over $100 and I couldn't afford it. I recorded some cello passages for the musicologist Ian Bent and asked where he thought I could find a copy—he had one in his office that he never looked at and gifted it to me with special thanks for a "perfectly mistuned octave." This book continues to be one of my prize possessions, and I never lend it out. I still have a particular fondness for the circuit diagrams as scores in the book (Mumma's *Mesa,* Neuhaus's *Max-Feed,* Rjewski's *Piece with Projectors and Photocell Mixer*) and hope to create my own circuit diagram score one day. In 2009 I eagerly purchased *Notations 21*[3] and brought it to school to inspire my students. Unfortunately I was not as careful with my copy of *Notations 21,* and have lost it, and to replace it I would have to pay over $US300. For those more interested in scholarly essays about notation the recent Orpheus Institutes *Sound & Score* is a fascinating collection[4].

While at Peabody I wrote the "The Notation of Interactive Music: Limitations and Solutions"[5] relying heavily on the survey I sent to composers of electronic music, framing my entire thesis around notation. My Master's thesis, contains chapters on various aspects of capturing sound on paper titled "Notation of Rhythm," "Notation of Interactivity," and "Notation as Art." My references included books and articles about the notation of early polyphonic music. Looking back I notice that I neglected ethnomusicologists' contributions to the arena of notation of timbre/notation of musics with different structural hierarchies. Udo Will claims that «[th]rough the very invention of writing systems, man has acquired means to cope with the elusiveness of sounds: the transformation from an aural-temporal form into a visual-spatial one. Sounds seem to be tamed and time seems more under control if treated spatially, however, this is only seemingly so because the accomplishments of such a transformation are limited and can at times be deceiving»[6].

In the answers to my survey, I was particularly struck by Elizabeth Hoffman's call for animated scores for electro-acoustic tape/live performance compositions[7]. While

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[2] Cage, John. *Notations*. (1969). New York, N.Y., Something Else Press.

[3] Sauer, Theresa, *Notations* 21. (2009), Mark Batty Publisher.

[4] De Assis, Paulo, William Brooks, and Kathleen Coessens. "Sound & Score." (2013).

[5] Schedel, *Ibid.*

[6] Will, Udo, "The magic wand of ethnomusicology", *Cahiers de musiques traditionelles*, n. 12 (1999), pp. 9-34.

[7] Hoffman, Elizabeth, "Animated Scores for Electro-acoustic Tape/Live Performer Compositions", *Proceedings of the Internaitonal Computer Music Conference*, 1998. <http://hdl.handle.net/2027/spo.bbp2372.1998.248> (03/19).

at SUNY Buffalo studying with Cort Lippe I wrote my first piece for acoustic instrument without electronic sounds, *Ov rla s: A Time Canvas* (2000) for Lujon[8] and Interactive Score, which I described as having «elements [that] appear and disappear on the score as the performer plays. The audience never hears the entire work, but gains a holistic view through repetitions of the material as heard through different overlays». I originally wanted to create a score using transparent overlays inspired by Cage's Plexigrams, but I couldn't get the speed of changes I wanted in the notation. Instead I used a Max patch with the lcd object that added and removed notes, mallet, dynamics, duration, and articulation changes in real time randomly. The speed of change was related to the volume—the louder the performer played, the faster the notation changed. In my thesis I included the entire score (which the performer never saw), as well as three variations once the algorithm had been running. Sometimes this meant that there were two mallet changes with no note played in between—creating a performance art element to the piece that I enjoyed and insisted that the percussionist perform, though there was no sonic result. Now animated scores have become fairly common, and I'm particularly inspired by Cat Hope & Lindsay Vickery[9], and Ryan Ross Smith's[10] contributions to this arena.

Looking back at my thesis, I could easily recreate this work based on my extensive notes about its history, compositional focus, influences, formal structure, and my performance notes as well as the pages containing (terribly pixelated) screen shots of the whole score and the punched out versions once the algorithm had been running. For my thesis, I had been tempted to include print-outs of the texts of my Max code for each piece, but my teachers wisely told me it would be too long; instead I focused on describing what was important to me about the pieces, something they thought would be much more valuable than pages of outdated code.

Moving scores do not necessarily have to have patches, but patches can «serve as both production interfaces and *de facto* notation, as knowledge of the programming environment enables one to 'read' them like a score»[11]. On the other hand, software quickly becomes outdated. When Miller Puckette developed his open source language, Pure Data (PD), the original idea was to make a real-time computer music performance environment like Max, but somehow to include also «a facility for making computer music scores with user-specifiable graphical representations»[12]. Puckette

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[8] A metallophone with individually-pitched thin metal plates that are attached to a resonant wooden box.

[9] Hope, Cat - Lindsay Vickery, "Screen scores: New media music manuscripts", Edith Cowan University Research Online ECU Publications, 2011.

[10] Smith, Ryan Ross, "An atomic approach to animated music notation" *Proceedings of the International Conference on Technologies for Music Notation and* Representation, 2015, <http://tenor-conference.org/proceedings/2015/06-RossSmith-AtomicAMN.pdf> (03/19).

[11] Grigore, Burloiu-Cont, Arshia and Poncelet, Clement,. "A visual framework for dynamic mixed music notation", *Journal of New Music Research* 46.1, 2017, pp. 54-73, p. 55.

[12] Puckette, Miller, "Using Pd as a score language", *Proceedings of the International Computer Music Conference*, 2002.

also developed PD repository project[13], which recreates classic works of electronic music for reperformance, but unfortunately only currently contains four pieces that can be performed: Philippe Manoury, *Pluton*, for piano and live electronics, Philippe Manoury, *Jupiter*, for flute and live electronics, Rand Steiger, *13 Loops*, for solo flute, viola, cello, bass clarinet, and marimba and Karlheinz Stockhausen, *Mantra*, for two pianos and electronics[14]. It is a lot of work to recreate the electronics for a piece—some composers are happy to let their pieces fade away after the original technology doesn't function and the pieces have ben performed and recorded[15]. I strongly believe composers need to make it as easy as possible for the musicologists, performers and technicians of the future to make our works reperformable.

During my doctoral studies, I continued to study notation, started a dance company, Kinesthetech Sense, and became intrigued by dance notation[16]. William Forsythe's works and writings are particularly evocative. For him a successful score «does not simply transcribe… but call[s] attention to how ideas produce movement and how movement occasions ideas»[17]. I continue to work with dance, and dance notation to this day. In 2011 I studied how composer Joseph Schillinger's speculative dance notation can be applied with modern tools, by converting his ruleset into linkage equations that are easily implemented in a computer[18]. During this time I also became a board member of the International Computer Music Association (ICMA), and edited several issues of *Organised Sound* (OS) as a collaborative venture between the ICMA and OS. In 2006, we focused on sustainability of electronic music, asking researchers to think about how the computer music of today will be played 500 years from now, and many of the articles touched upon notation as I hoped they would.

In my 2008 article for the International Symposium on Electronic Arts (ISEA) conference "Sustainability of Performing with Technology" I first called for "reperformance" of works, invoking Bourriaud who argued that artistic form could only be realized from a meeting between two levels of reality—for the homogeneity of a document does not produce art[19]. Art, or form, exists when the reality of the world and the reality of perceiving the world intersect. This was my first foray into philosophy, inspired by my peers in musicology at Stony Brook University, many of whom

[13] Puckette, Miller, "New Public-Domain Realizations of Standard Pieces for Instruments and Live Electronics", *ICMC. Proceedings of the International Computer Music Conference*, 2001.

[14] <http://msp.ucsd.edu/pdrp/latest/files/doc/> (03/19).

[15] Schedel, *Ibid*.

[16] Schedel, Margaret, Alison Rootberg, and Elizabeth de Martelly, "Scoring an Interactive, Multimedia Performance Work", *Proceedings of the New Interfaces for Musical Expression Conference*, 2008.

[17] Groves, Rebecca, Norah Zuniga Shaw, and Scott DeLahunta. "Talking about scores: William Forsythe's vision for a new form of 'Dance literature' ", in *Transmission in Motion: The technologizing of dance*, Bleeker M (ed.), New York, NY: Taylor & Francis, 2016.

[18] Schedel, Margaret, Nick Fox-Gieg, and Kevin G. Yager. "A Modern Instantiation of Schillinger's Dance Notation: Choreographing with Mouse, iPad, KBow, and Kinect." *Contemporary Music Review* 30.2, 2011, pp. 179-186.

[19] Bourriaud, Nicolas, et al. *Relational aesthetics*, Dijon, Les presses du réel, 2002.

have a strong phenomenological streak due to the influence of Don Idhe and his book *Listening and Voice*[20]. I am indebted to the musicologist Elizabeth de Martelly, who bravely volunteered to work with me when I was a new composition faculty member and introduced me to many new concepts and authors.

My interest in the combination of philosophy and music continues; at the 2017 ICAD conference I convinced Dr. Idhe to oversee a specific call on the philosophy of sonification asking specifically for articles on the philosophical and aesthetic developments.[21] I have also become very interested in embodied cognition. With dancer/choreographer Emily Beattie, I developed and wrote about a trivially simple interactive gestural system consisting of one point of control and a memory system, from a philosophy of embodiment[22]. Notation itself can be studied from a cognitive viewpoint; score reading can be seen as a technical representational practice[23] where «contingent surface-level features [are] leveraged by an underlying map-like representational structured [...] scores are seen to be highly conventionalized maps, and the notational symbols of scores constitute just one of multiple modes of representation and depiction harnessed by this framework»[24]. Scores are a types of map, and what is included can be just as important as what is left out.

I have begun to consistently use the word *reperformance* instead of *sustainability* because of a conversation I had after presenting a talk "Documentation vs. Notation in Computer Music" at the Bone Flute to Auto-Tune conference[25]. Reperformance is a much more specific term, and does not contain the environmental connotations of the word sustainability. In fact, when coming up with titles for the *Organised Sound* issue, we did worry that someone might write about the environmental impact of computer music. In studying embodied cognition, I am even more convinced that reperformance engages our embodied selves more strongly than video documentation. This year my artist collective arts.codes will curate and produce videos of scores for Score Follower[26], a website that creates videos of contemporary music scores that turn pages along with the accompanying recordings. We hope to encourage artists who do not usually score their work to create notations for the site, and encourage composers who use electronics to push the boundaries of what they are able to represent in a score.

[20] Idhe, Don, "Listening and voice: A phenomenology of sound", 1976.

[21] Tsuchiya, T. - Freeman, J., *Spectral Parameter Encoding: Towards a Framework for Functional-Aesthetic Sonification*, Georgia Institute of Technology, 2017; Alirezaee, P., Girgis, R., Kim, T., Schlesinger, J. J., & Cooperstock, J. R., "Did you Feel that? Developing Novel Multimodal Alarms for High Consequence Clinical Environments", Georgia Institute of Technology, 2017; Landry, S., & Jeon, M.. "Participatory design research methodologies: A case study in dancer sonification", Georgia Institute of Technology, 2017.

[22] Beattie, E., & Schedel, M., "Inscribing Bodies: Notating Gesture", in *International Symposium on Computer Music Multidisciplinary Research*, Springer, Cham, 2017, September, pp. 273-283.

[23] Penny, Simon, *Making Sense. Cognition, Computing, Art, and Embodiment*, MIT Press, 2017.

[24] Miller, Daniel, "Are Scores Maps? A Cartographic Response To Goodman", in *Proceedings of the International Conference on Technologies for Music Notation and Representation*, 2017.

[25] <https://cstms.berkeley.edu/current-events/bone-flute-to-auto-tune/> (03/19).

[26] <https://scorefollower.com/> (03/19).

Notation and the score are separate concepts, but are intertwined with cultural, ontological and semiotic inferences, all of which impact the material fabrication we call the score[27]. I like the very open definition of a score as a «coded tool in the arts… a two-dimensional […] artefact that allows for multiple performances […merging] the fixed and the dynamic, space and time»[28].

Within the simple three roles of notation: recording, analysis and generation[29], there are an infinite variety of solutions (much like computer programming). Good notation provides means for transcribing music, can (with training) be read and played (and ideally can be accessed, read and played over long periods of time), and is extensible[30]. More specifically Anne Veitl specifies that a score must be 1) material; 2) visible; 4) performative; 5) systemic; and 6) causal[31]. Although I find the word *visible* problematic as it is not inclusive of the blind community who certainly can read and interpret scores, I think "sensible out of time" might be a better phrase, when approaching a new score I now keep these concepts in mind.

I believe that any non-fixed artistic event that takes place over time can benefit from studying dance and music notation, and even stage directions. In my opinion, documentation of an event is not sufficient for a living practice. If we think of notation as a system that «provides a medium for the exchange of information, and facilitates the negotiation of shared goals among those who may be involved in the creation of space [or sound]»[32], it is easy to expand this to complex installations. Notation, along with performance practice, «stabilizes the ontological identity of the works they are intended to articulate»[33]. There is a mapping from sound to notation that is decoded by the performer/reconstructor. Moreover, the function of a score varies from composer to composer. «For Stockhausen, the performance is made in his service; the piece remains his and the performers should divine his intention even when it is not written down. For Cardew, the score is the responsibility of the performers once it is composed»[34]. There cannot be a simple prescriptive practice for scoring, it will depend

[27] Blackburn, Andrew, Jean Penny, "Timbral Notation from Spectrograms: Notating the Un-Notatable?", *Proc. of the Int. Conf. on New Tools for Music Notation and Representation TENOR*, 2015.

[28] Coessens, Kathleen, "The Score beyond Music" in P. de Assis, W. Brooks, K. Coessens (eds.), *Sound and Score: Essays on Sound, Score and Notation*, Leuven University Press, Ghent. p. 178, 2014.

[29] Wiggins, Geraint et al., "A framework for the evaluation of music representation systems", *Computer Music Journal* 17.3, 1993, pp. 31-42, p. 31.

[30] Sonnenfeld, Alexander - Kjetil Falkenberg Hansen, "S-notation: A complete musical notation system for scratching and sample music derived from 'Theory of Motions' ", *TENOR*, in *Proceedings of the International Conference on Technologies for Music Notation and Representation*, 2016.

[31] Veitl, Anne, "Musique, causalité et écriture: Mathews, Risset, Cadoz et les recherches en synthèse numérique des sons", *Musique, Instruments, Machines, Paris, OMF-Paris IV Sorbonne*, 2006, pp. 235-251.

[32] Westby, Syuko Kato - Ruairi Glynn, "Fabricating Performance: Reciprocal Constructs of Dance Notation", *Nexus Network Journal*, 20.1, 2018, pp. 75-94, p. 77.

[33] Kim-Boyle, David, "The Ontology of Live Notations through Assemblage Theory", in *Proceedings of the International Conference on Technologies for Music Notation and Representation*, 2016.

[34] Anderson, Virginia, " 'Well, It's a Vertebrate…': Performer Choice in Cardew's Treatise", *Journal of Musicological Research* 25.3-4, 2006, pp. 291-317, p. 295.

on the artist and the work, becoming a «symbolic representation […] an aggregate of many parameters, functioning through abstract, contextual implications for how it should be interpreted»[35]. What the «creator chooses to represent, omit or stylize»[36] becomes a blueprint for the performance or reperformance itself.

In recent years I've become intrigued by the fact that an instrument itself can become a type of score. As Enrique Tomás writes musical work can be seen as «not only defined by the instrument, but more importantly, by the act of playing the instrument. The performer's role [is] to reveal instances of the musical work inherently integrated in the circuitry»[37] Tomás is writing about his own electronic instruments, but it is easy to see that the statement «affordances are fully mediated by the embodied relationship between instrument and performer»[38] can apply equally to acoustic instruments. I had the pleasure of premiering Mark Applebaum's *Metaphysics of Notation* (2010) on electric cello with percussionist Corey Fogel. The 72 foot hand-drawn score with two corresponding mobiles was installed at Cantor Arts Center at Stanford. We were instructed to perform the score non-linearly and to interpret the notational shapes in sound however we wished. At one point Fogel bent long metal strips into shapes he saw in the notation – using the affordances of his instrument to create a primarily visual experience with the sonic result as secondary. This embodied notation synthesizes dance and music in a compelling manner, and pleased Applebaum who had never expected that particular physical interpretation of his drawing.

In both the arts and the sciences there is a need to «communicate ideas or concepts»[39] by creating a reduction of the complete work, and the two fields are not as different as many practioners believe. The arena of human computer interaction (HCI) gives us valuable insight into scoring. Alan Blackwell used Thomas Green's cognitive dimensions of notation (computer languages as information structures) – Visibility, Comparability, Dependencies, Cognitive Load, Liveness, Conciseness, Sketchability, Marginalia-ability, Consistency, Mutability, Role, Commitment, Error-Prone, Mapping, Abstraction, Virtuosity, and Learnability[40] – to explain why musical notation has persisted. When designing notation of interactive systems for creative purposes, I think that it is useful to consider these properties. I'm especially interested in virtuosity vs. learnability. I often create installation versions of my interactive systems for the public to engage with before (or after) experiencing a virtuosic performance of the work: *Beat Patterns* (2003), *Corporealization of Mictrophone* (2004),

[35] Gottfried, Rama, "SVG to OSC Transcoding: Towards a platform for notational praxis and electronic performance", in *Proceedings of the International Conference on Technologies for Music Notation and Representation*, 2015.

[36] Miller, Daniel, *Ibid.*

[37] Tomás, Enrique, "Musical Instruments As Scores: A Hybrid Approach", in *Proceedings of the International Conference on Technologies for Music Notation and Representation*, 2016.

[38] *Ibid.*

[39] Bacon, Benjamin, "Tufte Design Concepts In Musical Score Creation", in *Proceedings of the International Conference on Technologies for Music Notation and Representation*, 2015.

[40] Green, T. R., "Cognitive dimensions of notations", *People and computers V*, 1989, 443-460.

Les Soers de Mélasse (2004), *FleshLightMovement* (2006), *Ah(void)* (2008), *Chromatic Presence* (2012)*, and *After | Applebox* (2018). I'm currently working with Jocelyn Ho and Matthew Blessing on *Women's Labor,* a series repurposing older domestic tools of women's work into new interfaces for musical expression[41]. The public will be able to use these new instruments in an installation setting as well as seeing a virtuosic performance by Jocelyn Ho. We will observe the public interacting with the instruments and interview them about the experience before creating a notation system.

There is an amazing philosophical debate about what exactly constitutes a work beyond ownership of the creative concept; some believe the performance is the true essence of the creative work, while others believe that these «performed musical sounds are at best regarded as mere instances of the musical work, which is defined by the score»[42]. I think that the music is in the combination; much as the discovery of quantum mechanics led John Dewy to the conclusion that:

> […] the separation of rhythm and symmetry from each other and the division of the arts into temporal and spatial is more than a misapplied ingenuity. It is based on a principle that is destructive, so far as it is heeded, of aesthetic understanding. Moreover, it has now lost the support from the scientific side it was once supposed to have. For physicists have been forced in virtue of the character of their own subject-matter to see that their units are not those of space and time, but of space-time. The artist made in action if not in conscious thought this belated scientific discovery from the very beginning. For he has always dealt perforce with perceptual instead of conceptual material, and, in what is perceived, the spatial and temporal always go together. It is interesting to note that the discovery was made in science when it was found that the process of conceptual abstraction could not be carried to the point of excluding the act of observation without destroying the possibility of verification[43].

A wonderful book on the combination of space-time, arts and technology is Chris Salter's *Entangled*[44]. For me, the beauty of a creative practice is that the conceptual plus the perceptual equals the art. I am also intrigued by the practical aspects of production and notation, and how simple choices in lighting and staging can have an outsize impact on the audience or performer respectively.

3. Thought Experiment: Light Prop

I turn now to a thought experiment about how to notate a work of twentieth cen-

[41] J. Ho, M. Schedel, M. Blessing, "Women's Labor: an installation and concert of new and old "feminine" instruments", *Alliance of Women in Media Arts and Technology Conference University of California*, Santa Barbara, CA, 2019.

[42] Park, So Jeong, "Sound and Notation: Comparative Study on Musical Ontology", *Dao* 16.3, 2017, pp. 417-430.

[43] John, Dewey, "Art as experience", New York: Minton, Balch, and Company, 1934, p.190.

[44] Salter, Chris, *Entangled: Technology and the Transformation of Performance*, MIT Press, 2010.

tury time-based art: László Moholy-Nagy's *Light Prop for an Electric Stage*. It might seem odd to choose a work where sound is not a main component of the experience to write about in a chapter ostensibly about music notation. I chose this piece because I think multi-media artists can learn much from studying music notation, and visa-versa. By starting with a work where sound is not the primary component, and indeed might not even be worth notating at all, we free ourselves from the burden of the legacy of music notation and can approach the thought experiment with more liberty. I am not trained in visual art, but I have a sense of form over time and enjoy creating time-based visuals without the spectre of former teachers questioning and influencing my choices. I think approaching a thought experiment about notation without a sonic focus will yield more creative results.

Light Prop for an Electric Stage was conceived in 1922-30, built in 1929-30, and refined throughout the artist's lifetime. Edit Tóth eloquently called this piece a «light-generating kinetic device rooted in a multiplicity of cultural practices, including jazz, theater, cinema, optical toys, and architecture… offer[ing] an inventive example of modern design and a challenging phenomenological experience»[45]. The purpose of this kinetic sculpture was to create moving lights and shadows, and it is now seen as a key work in the history of twentieth century art as an important pre-cursor to video arts/abstract cinema. The mechanism itself is a 4 foot cube with an aperture on one side with an assortment of different colored light bulbs that are programmed to turn on and off in a two minute sequence. Between the aperture and the lights are a variety of gears set on a rotating base connected to materials with various hues, opacities, perforations/frets and albedos that cast shadows, reflections, and colored light fields onto the surrounding walls (and audiences). An unnamed architect and a machinist built the original sculpture to Moholy-Nagy's specifications[46], with additional help from the German electrical company AEG; the artist subsequently refined the mechanism himself.

Moholy-Nagy produced a "score" for the work, which is merely a chart dictating when each light should come on, but could we create a score for the work that would allow a reperformance of *Light Prop for an Electric Stage* without access to the original sculpture? I'm deliberately posing   a more difficult problem than David Wetzel's recreation of Thea Musgrave's *Narcissus* (1987) where he had access to the original equipment, a Vesta Koza DIG-411. Similar to the light chart, the Musgrave's score indicates dial positions of the original hardware[47].

There have been many copies made of the sculpture because the original work is owned by Harvard University, and due to its fragile construction is only activated once a month and it cannot travel. Indeed the original work has «suffered damage,

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[45] Tóth, Edit, "Capturing Modernity Jazz, Film, and Moholy-Nagy's *Light Prop for an Electric Stage*", *Modernism/modernity* 22.1, 2015, pp. 23-55.

[46] Gewertz, K., Light Prop Shines Again, 2007, July 19, Retrieved Sept. 23, 2008 from <http://www.news.harvard.edu/gazette/2007/07.19/00-modulator.html>.

[47] Wetzel, David Brooke, "Analysis and Reconstruction of Interactive Electroacoustic Works for Obsolete Technology: Thea Musgrave's Narcissus", in *Proceedings of the International Computer Music Conference*, 2004.

alteration, inappropriate restoration, and mechanical instability»[48]. The most accurate reproduction to date was commissioned by the Tate Modern in 2006 that has now travelled the world, but in creating a new machine Harvard «expressly stipulated that the replica should not be considered a work of art»[49]. However art historian Nan Rosenthal believed that «Moholy didn't really treat it as a work of art. He treated it as a machine to produce light effects, and so felt perfectly comfortable either replacing pieces or adding structural elements to stabilize it»[50]. Beyond the Light Prop itself Moholy-Nagy believed that «it was the idea behind an artwork that was important, not whether the artist executed it himself»[51]. The replication works more smoothly than the original, has been seen by more people, and the resultant light and shadows are probably more accurate to Maholy-Nagy's original vision, yet we still believe the aura[52] of the original machine is more compelling/accurate. The sculptors who created the replication for the Tate were able to work from the original plans as well as the physical sculpture, but if we only had access to a set of recordings of the output of the Light Prop, including Moholy-Nagy's own film *Lichtspiel,* could we retroactively create a score that would allow other artists to recreate the work?

By closely reading Moholy-Nagy's description of the piece it is possible to begin to understand what he considered important. The artist himself continuously refined the piece. His thought process can be seen through his evolving titles for the work: "The Light Prop relat[ing] to lighting design in theater and film production, the Light Display Machine highlight[ing] its mechanical and performing aspect (and also relation to Calder's mobiles), and the *Light-Space Modulator* emphasiz[ing] its space forming and architectural implications[53]. A close reading of the fullest description we have of the installation we have written by Nagy himself[54] can help with our thought experiment. In the first sentence Moholy-Nagy writes that the purpose is to demonstrate both plays of light and manifestations of movement. Would a sketch programmed in Processing[55] and presented using a data projector be an accurate reperformance? It would be appropriate to choose Processing for this recreation because «Moholy-Nagy not only influenced the construction of digital imagery through his writing, but has a

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[48]   Henry Lie, "Replicas of László Moholy-Nagy's Light Prop: Busch-Reisinger Museum and Harvard University Art Museums", *Tate Papers* Autumn 2007, <https://www.tate.org.uk/research/publications/tate-papers/08/replicas-of-laszlo-moholy-nagys-light-prop-busch-reisinger-museum-and-harvard-university-art-museums> (01/19).

[49]   Gewertz, K., *Ivi.*

[50]   *Ibid.*

[51]   *Ibid.*

[52]   Benjamin, Walter, "The work of art in the age of mechanical reproduction", *Visual Culture: Experiences in Visual Culture*, 1936, pp. 144-137.

[53]   Tóth, E, "Capturing Modernity Jazz, Film, and Moholy-Nagy's Light Prop for an Electric Stage", *Modernism/modernity*, *22*(1), 2015, pp. 23-55.

[54]   <http://www.medienkunstnetz.de/works/licht-raum-modulator/> (03/19).

[55]   An open source software language developed in 2001 for learning how to code within the context of the visual arts, <https://processing.org/> (03/19).

direct connection to contemporary software designers, like John Maeda, Ben Fry and Casey Reas, who studied in the visual design program founded by his protégé, Mr. Kepes, at the Massachusetts Institute of Technology»[56].

Does the "work" consist of only the resultant light and shadows, or does the physical presence of the sculpture impact the artistic experience? Would the humming of the digital projector be the only sound, or should we also try and capture the «the repetitive noises (the flipping of the ball, the rocking of connected planes and switching circles, meshing gears, and the subdued mechanical humming of the motor) that constitute the acoustic dimension»[57] of the work?

If we decide that the physical presence of a sculpture is necessary for an accurate reperformance, could we use updated materials or would we want a "period reperformance." Originally applied to older classical music, period performance attempts to recreate the music of the past as closely as possible, with period instruments and the study of stylistic and technical aspects of performance. I hear debates today in electronic music concerts about if we should playing pieces off the original magnetic tape vs. a computer. Could the "best possible play of shadow formations" include smart materials that bend and change opacity with and electric current? I think everyone would agree that a recreation should adhere to Moholy-Nagy's three distinct sections with a playful character as designated in his description, but what about the idea of "countless optical conclusions"? Would a reperformance in virtual reality that allows avatars to place different materials beyond the physical limitations of gravity, friction, and light be true to the spirit of the work? What about a future when humans have cybernetic implants that allow sensation beyond our current capabilities? *Light Prop for an Electric Stage* is a fairly simple mechanism, yet it can help us hypothesize about the best practices for notating immersive work.

There are distinct differences between notation, reperformance, recording and archiving. Thus far I have touched on notation and reperformance; recording is a fairly straightforward preservation technique, while archiving includes much more data than a simple recording. Archiving *Light Prop* is a completely different task to notating it, and one that I am not an expert in. Ideally notation should work with archiving so there is a way to access as much as possible of the initial work through documents while allowing for a reinterpretation to be experienced fully. A reperformance of *Light Prop* would depend on the archival materials included with the object itself. I turn now to my colleague Federica Bressan, an expert in the field of multimedia installation preservation. When I was researching the next section on archiving installations I kept turning to her articles, and when I looked at her sources the quotes and references she chose elucidated the points I wanted to make. I decided to go to the source, and she generously agreed to write the following section.

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[56] Rawsthorne, Alice, "A Life of Light and Shadow", *New York Times*, Oct 18, 2009.

[57] Tóth, Edit, "Capturing Modernity Jazz, Film, and Moholy-Nagy's Light Prop for an Electric Stage", *Modernism/modernity*, 22.1, 2015, pp. 23-55.

4. On preservation and documentation

With the blurred line between installations and performances, those who are interested in the preservation of the former must be also concerned with the preservation of the latter. Despite the challenges that are specific to one or the other, there is a fundamental overlap that resides in the live, transitory nature of these works, often dependent on – as they have been called – "unstable" media[58]. From the viewpoint of preservation, this "instability" is well captured in the expression "un-archivable"[59]. Something "archivable" is understood to be stored "as is", and this is not the case with installations and performances, for obvious reasons related for example to their scale, the moving parts, and the participation of humans as part of the work.

In the new perspective imposed by these works, the concept of "as is" is radically challenged: the work of art is no longer a «unique piece created by an artist but a process of cultural participation involving the public, the work itself, and the museum»[60]. If these elements are recognized to constitute the work, they should all be reflected in the complex object, or package, that is the "archive master". The idea of "archive master" is taken from the field of audiovisual preservation[61], where the awareness that the physical carriers will eventually degrade to the point where their content is irrecoverable has informed preservation practices almost from the beginning, roughly speaking in the late 1990s. Since then, the preservation of audiovisual documents has been predicated on the dichotomy between content and container, and mostly seen as content migration. In general terms, an archive master is an organized data set that groups all the [relevant] information represented by the source document [both content and container], as well as the process of content migration[62]. This is an important observation because even if the same dichotomy cannot really be found in installations and performances, they share, in a way, the fate of audiovisual carriers, except their degradation happens differently and much faster: it can be argued that most works "disappear" every time the exhibition or performance is over.

Considering the lessons learnt in the audiovisual field can be useful[63], especially in the light of the fact that the traditional approach of museums has maintained itself

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[58] Capturing Unstable Media project (2003) led by the V2_ Lab for the Unstable Media in Rotterdam, NL: <http://v2.nl/archive/works/capturing-unstable-media> (03/19).

[59] Ernst, Wolfgang, "Underway to the Dual System. Classical Archives and/or Digital Memory", in "Netpioneers 1.0. Contextualizing Early Netbased Art", Berlin (Germany), Sternberg Press, 2010, pp. 81-99.

[60] Barbuto, Alessandra - Barreca, Laura, "Maxxi pilot tests regarding the documentation of installation art", in "Preserving and exhibiting media art", Amsterdam (NL), Amsterdam University Press, 2013, pp. 181-195.

[61] Preservation copy or master in: IASA-TC 04, "Guidelines on the Production and Preservation of Digital Objects", IASA Technical Committee, 2004.

[62] Bressan, Federica - Canazza, Sergio, "A Systemic Approach to the Preservation of Audio Documents: Methodology and Software Tools", *Journal of Electrical and Computer Engineering*, 2013, p. 21.

[63] Bressan, Federica "A Philological Approach to Sound Preservation", in Levenberg L., Neilson T., Rheams D. (eds.), *Research Methods for the Digital Humanities*, Palgrave Macmillan, Cham, 2018, pp. 342-261.

diametrically opposed, and it still influences current preservation policies and practices: the focus is on "things" (rather than processes and intangibles), the concept of "original" still applies (along with its aura), and many conservators attempt to «fix the processual and fluid nature of these works»[64] to fit established cataloguing standards first designed for traditional *beaux arts*. Identifying what *can* be preserved and what *should* be preserved is not an easy task. Installations and performances require a fundamental re-thinking of documentation modelling, one based on events and processes rather than on fixed objecthood.

For the hardware (in the broad sense, every tangible component of the work) and software components of the work, a useful approach is to assign functional «significance to display equipment, its relation to the worlds identity based on conceptual, aesthetic and historical criteria, and the role the equipment plays in the work»[65]. For each component, we can ask: is the equipment functional or is it (also) conceptually important? Is the equipment visible or hidden from view? The *decision tree* developed by the DOCAM Conservation and Preservation Committee[66] «allows stakeholders to identify the problems and potential solutions associated with preserving works that incorporate technological components», and can guide the decision making process at the time when problems with the maintenance of the equipment arise. Depending on the work and its specific problems, a simple replace with identical or equivalent parts might be the best solution. However, the long-term problems of preserving the work *and the experience* remain open.

Current documentation strategies are still grappling with these open problems, but to their credit it should be said that the joint efforts of researchers and curators has contributed to a significant advancement in this field, both theoretically and in practice. Documentation is seen as a process, that spans across different stages of the work's life cycle: it includes information about the work's «condition, its content, its context, and the actions taken to preserve it»[67]. It is widely accepted that in most cases, it is only the documentation that will survive the work, thus acquiring a new importance as the [only] source of knowledge about the work, though not necessarily in competition with the work.

Besides the work in and of itself, the idea, the concept or [conceptual] model can be the object of preservation. The Variable Media Network (VMN) proposed a strategy where artists are encouraged to define their work independently from medium so that the work can be translated once its current medium becomes obsolete[68]. The artist's intent is considered by a number of international museums as the guiding

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[64] Dekker, Annet "Methodologies of Multimedial Documentation and Archiving", in *Preserving and exhibiting media art*, Amsterdam (NL), Amsterdam University Press, 2013, pp. 149–169.

[65] Laurenson, Pip, "The management of display equioment in time-based media installations", *Studies in Conservation*, 2004, 49:sup2, 49-53, DOI: 10.1179/sic.2004.49.s2.011.

[66] DOCAM's Decision Tree: <http://www.docam.ca/en/restoration-decisions/a-decision-making-model-the-decision-tree.html> (03/19).

[67] Dekker, *Ibid*.

[68] *Ibid*.

principle for their documentation[69], and extensive audiovisual interviews are thought to optimize the process of capturing his or her intention (often based on the interview model proposed by the Forging the Future project[70]). When the artist is uninterested, deceased, or unavailable for any reason, someone else is burdened with the responsibility of making decisions about the work's presentation and preservation with partial information at hand. Sometimes the restorer's domain needs to extend into the curatorial one. The decision tree mentioned above might give a sense of direction in situations of doubt, and shared (ideally standard) practices are preferable over individual efforts to reinvent the wheel under the virtuous name of "adapting existing practices."

Multi-layered models have also been devised to capture the complexity of these works in documentation. Rinehart's Media Art Notation System (MANS)[71] has three layers of implementation: the *conceptual model* of documentation, the preferred *expression format* (vocabulary) for the model, and the *score*, which serves as a record of the work that is database-processable. The core concepts form a "broad strokes" description of the work that can be used by the artist or museum at the time the work is created or collected. Further details can be filled in later in the life of the work, in line with the idea of documentation as a process.

A different model for preservation, that does not prescribe a model of the work, was introduced by one of the authors[72] in collaboration with the University of Padua, Italy. The model is organised in four layers, each of which serves as a container for specific types of documents. The layers are not in a hierarchical relation and were inspired by a methodological framework for the preservation of scientific data. They adopt the conceptual tools and the terminology of computer science: four levels of abstraction from the *bits* (any part of the original installation that can be preserved "as is"), to *data* (technical notes, comments about the realisation of the installation, including high level descriptions of algorithms used), to *record* (any element that was modified or updated in respect of original installation in order to re-interpret the installation), to *experience* (any document that bears witness to some aspect of the human-machine interaction).

Summarizing, the problems of preservation and maintenance of installations and performances, and their re-interpretation, can be formulated as follows:

1. Preservation and maintenance: whether the replacement of an element violates or "decreases" the authenticity of the piece, is a philosophical question. As such, it has no right or wrong answer. This does not legitimize us to inaction, on the contrary it calls us to take responsibility for our (informed, reasoned) choices, which should always be declared, owned, and documented.

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[69] Hummelen, Ijsbrand "Conservation strategies for modern and contemporary art: Recent developments in the Netherlands". CR: interdisciplinair vakblad voor conservering en restauratie (2005).

[70] Variable Media Questionnaire, <http://variablemediaquestionnaire.net> (02/19).

[71] Rinehart, Richard "The Media Art Notation System: Documenting and Preserving Digital/Media Art". Leonardo, 2007m 40(2), pp. 181–187.

[72] Bressan, Federica - Canazza, Sergio, "The challenge of preserving Interactive Sound Art: A multi-level approach", *International Journal of Arts and Technology*, 2014, 7(4), pp. 294-315.

2. Re-interpretation: whether it is vetted by the artist or it depends on someone else's choices, any new staging of a previous piece, that is not identical to it (and it rarely is, almost by definition) is to be considered a new version (in case it is vetted by the artist) and for all intents and purposes a new interpretation (vetted or not).

This also applies to preservation strategies that involve migration, emulation and virtualisation, precisely because the ultimate question about authenticity cannot be answered (see previous point), the "distance" or divergence from the "original" or previous cannot be objectively *measured*. It is undeniable, however, that there are better and worse approaches, where better is defined as informed, approved by a team of experts rather than a single individual, and aided by existing tool like the DOCAM decision tree, the Variable Media Questionnaire, and tools alike.

Taking into account the context where the work was created and exhibited complicates things because we often lack the historical distance to make objective assessments about our own cultural landscape, let alone a past one. An extreme, but intellectually legitimate, conclusion that may follow this observation is that ideal preservation is an impossible task, betrayal and bias are inevitable, and therefore we should not even try because any action results in fabrication. As a consequence, we should sit and watch a wealth of creative potential and intellectual labour crumble in front of our eyes.

There is another, equally rational and legitimate, position, which moves from the same premise: "ideal" preservation is an impossible task. But then it puts in action a different set of ethical values: we acknowledge that reflecting upon "un-archivable" works, documenting our choices, working in teams, produces useful results both within and without preservation per se. It fosters an intellectual discussion, setting the conditions for the development of a stimulating cultural ethos that inevitably leads to academic advancement and artistic creativity. It prevents the complete loss of artefacts, practices, stories, and ultimately heritage goods, present and future memory and identity. It keeps us attentive, on guard for unintentional "fabrications", and thus actively engaged with the heritage. Manovich[73] asked whether «it makes sense to theorize the present when it seems to be changing so fast.» His answer resonates with the ethical values just exposed: the documentation we produce today is a "record of possibilities", and even if the future proves us wrong (which can hardly happen: it is more accurate to say that the future will learn from our mistakes and do better because it will build on them), it will paint a «horizon which was visible to us today but later became unimaginable»[74].

5. Conclusion

My first piano teacher was a Glenn Gould scholar who had studied with Nadia Boulenger. I had trouble memorizing pieces, and she would ask why I had so much

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[73] Manovich, Lev, *The Language of New Media*, Cambridge, Mass., The MIT Press, 2002.

[74] *Ibid.*

trouble if Gould could bring a score for a Bach fugue into a room without a piano, and come out able to play it by memory. Musically I grew up in the shadow of this great pianist, and yet I have a soft spot for him, even more so since I discovered he gave up performing live and focused on creating work in the recording studio. Recently the score Glenn Gould used when creating his second landmark recording of *Aria mit verschiedenen Veränderungen* (known as the Goldberg Variations) has come up for auction. I use the word "create" very deliberately: this 1981 recording is famous because Gould used extensive studio techniques to fashion the recording changing his own timing, microphone placement, and recording levels, and finally splicing together many different takes to create an interpretation that he most likely would not have come to by performing the piece straight through, and might not be even be possible to perform live without robotic intervention. Pianists can now use Nicholas Hopkins transcription of the recording to recreate a performance that never occurred[75]. Gould's first recording of the Goldberg Variations was in 1955 and it launched his career, and the popularity of this stunning work. As shown in Sony's 2017 release "The Goldberg Variations - The Complete Unreleased Recording Sessions June 1955" Gould also recorded an astonishing number and variety of takes in his original release, but this recording didn't have nearly the number of splices as the second. The newly found manuscript for the 1981 session contains «minute detail of his assembly of the recording»[76] and shows how «the performer's once sacrosanct privileges are merged with the responsibilities of the tape editor and the composer»[77].

I'm almost the opposite of Gould—while I understand the value of recordings I have never felt comfortable with my works being recorded. I try to create pieces that can be dramatically different each time they are performed, and I do believe that composer-endorsed recordings become a type of *urtext* (an *urklang* perhaps) and an immediate arbiter of what is an "authentic" performance of a piece[78]. If as Takemitsu says the measure of the 'only performance' is the music each time it is heard, and that continues to be the measure for every performance[79], then I believe it is crucial to create notation of works so that they can be re-performed. James Joyce may have said he took credit for all the interpretations by every *Ulysses* scholar in the world, whether any of them had occurred to him personally or not[80]. With music notation it is much easier to trace interpretations back to the source, except perhaps with open/aleatoric/ graphic scores such as *The Metaphysics of Notation*. Bach could not have conceived of

[75] Hopkins, Nicholas (ed.), *Glenn Gould's Goldberg Variations: A Transcription of the 1981 Recording of the Goldberg Variations by Johann Sebastian Bach*, New York, NY Carl Fischer Music, 2016.

[76] Bonhams Books and Manuscripts, "A Holy Grail Of Glenn Gould Manuscripts", 2018. <https:// www.bonhams.com/press_release/26779/> (02/19).

[77] Gould, Glenn, "The prospects of recording". *High Fidelity*, 16.4, 1966, pp. 46-63.

[78] Shafer, Seth, "Performance practice of real-time notation", *Proceedings of the 2016 International Conference on Technologies for Music Notation & Representation*, 2016.

[79] Takemitsu, Toru, et al., *Confronting silence: selected writings*, Vol. 1, Scarecrow Press, 1995.

[80] Holland, Bernard, "Debussy's Ghost Is Playing, So What Can a Critic Say?", *New York Times*, July 24, 2007.

a studio recording of his piece played on modern piano and streaming over the internet into headphones, yet he would be able to recognize his work. We should strive for notation that allows recognition of the work in future interpretations, rather than forcing increasingly improbable perfect reconstructions on period software/hardware, or relying on frozen recordings.