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McLuhan.js: Live Net Art Performance with Remote Web Browsers

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MCLUHAN.JS: LIVE NET ART PERFORMANCE WITH REMOTE WEB BROWSERS

A Dissertation

Submitted to the Graduate Faculty of the Louisiana State University and Agricultural and Mechanical College in partial fulfillment of the requirements for the degree of Doctor of Philosophy in

The School of Music

by

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B.A. Kenyon College, 2007
M.F.A. Mills College, 2010
August 2016
To my loving family

Clover, Henry, Lydia, Mark, Lauren, and Clarke
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McLuhan.js is a media art performance platform which engages with the web browser as a source of form and content. The platform enables a new performance scenario: a performer creates live net art actions in the browsers of remote viewers. McLuhan.js contains client-side and server-side tools for creating net art, as well as a live coding performance interface. These tools are designed to remotely control real-time collages of web media, browser windows, and computer art tropes.

While the McLuhan.js toolkit is deliberately of its time, it is so because it participates in a tradition of 20th-century artists who reflected on their daily lives by incorporating contemporary communications media into their creative practice. These artists consistently looked outward to found media as sources of inspiration. Empirical and experimental investigations into new media lead these artists to work directly with a medium's raw materials—often in subversive or unorthodox patterns—to create new forms of art from the technological fabric of their era.

The Last Cloud, a net art performance using McLuhan.js, reveals a dialogue with this artistic history. Its composition is described herein, along with a description of the McLuhan.js toolkit and a survey of the history it inherits.
1. MEDIA, THE MODERN MUSE

He paints [the Eiffel Tower and the Seine] not as symbols to invoke a universe of expanded meaning, but as the most familiar natural objects in his world.

—Roger Shattuck on Henri Rousseau, *The Banquet Years*

The twentieth century, for its full duration, witnessed a lineage of artists who reflected on their daily lives by incorporating industrial and electronic communications media into their art. In the process, these artists worked with new media in ways both unconventional and direct, looking outward to their media as primary sources of inspiration. Increasingly, certain groups of twentieth century artists took an exogenous approach to art, in which subversive interactions with a communication medium’s core materials provided a source of new content. By the late 20th century, media in art were consistently repurposed as tactile instruments to generate content, as opposed to being means of reproducing content.

Pierre Schaeffer’s (1910-1995) investigations into *musique concrète* in 1948 nicely illustrates this tendency. To compose *musique concrète*, Schaeffer worked directly with audio recording equipment as an instrument, rather than using the studio as a tool for recording a reproduction of a music performance. Schaeffer opens his creative process to the new possibilities of his medium, the recording studio, and creates a new genre of music with its own stylistic tendencies, as exemplified in his *Cinque études des bruits* ("Five Studies of Noises", 1948). This approach is not specific to music, however; Schaeffer’s work is part of a broader interdisciplinary history which connects Parisian modernists, New York media artists, Filipino composers, and Dutch internet artists.
This history begins in modernist Europe at the turn of the 20th century with artists using contemporary industrial life as a subject, and the subsequent introduction of industrial materials into assemblages by Pablo Picasso (1881-1973), Marcel Duchamp (1887-1968), and artists of the Futurist and Dada movements of the 1910s. The narrative continues through the high media art period of post-war America and Europe, featuring media collages using televisions, film, vinyl, and text, among other media. Applying the same perspective to networked media, a community of musicians in the 1960s and 70s used electronic invention to repurpose radios and telephones as instruments capable of new musical forms. With the introduction of desktop computers and web browsers in the 1980s and 90s, these perspectives again formed the foundation for a new generation of net artists who inherit media art's legacy, and in whose genre McLuhan.js participates.

Daily Life’s Materials

In the late nineteenth century, Paris was a center of leftist political activity where demonstrations, theatrical salons, and lively cafes made it so that all of Paris “had become a stage, a vast theater for herself and all the world.” The new medium of the photograph turned attention to the ordinary as a subject, and Impressionist artists of the Salon des Independents in Paris began to paint scenes from their daily

lives instead of the subjects common to Romantic or Neo-classical painting: religious, allegorical, or historical imagery.

Impressionism is described as “a different way of seeing, it was an art of immediacy and movement, of candid poses and compositions.”¹ These tendencies for candor and immediacy can be seen in Alfred Sisley’s *Vue du Canal Saint-Martin* (*View of Saint-Martin Canal*, 1870), a scene as ordinary as that of his walk home (Figure 1). The painting does not depict a historically significant event, instead it elevates forms found in daily life. By taking his easel out into the world, Sisley brings his materials out of the studio and engages with the world around him.

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This same confrontation between art and life is seen when Pablo Picasso pastes a flat piece of a wicker chair onto a section of his painting *Nature-mortè à la chaise cannée* (“Still Life with Chair Caning”, 1912), declaring it a *collage* (“gluing”).³Rather than art’s materials entering life, as with Sisley, now Picasso shows life’s materials entering art. Picasso, who came of age in the post-impressionist milieu of *fin-de-siècle* Paris, leaves these materials as they are—raw—and assimilates their form and texture into his work. Art historian Jean Clay describes this as “the replacement of the representation of things by their presentation.”⁴

**Newspaper as Material**

Among the materials used in their collages, Picasso and his intellectual collaborator Georges Braque (1883-1963) especially gravitated toward an artifact of mass-media from daily life: the newspaper. The rapid publication of cheap “penny newspapers” was a recent phenomenon in 1912, and, like photography, it was changing how the industrialized world received information. In Picasso’s *La bouteille de Suze* (*Bottle of Suze*, 1912), he affixes several newspapers around the figure of a table, at the center of which is a label from a bottle of Suze liqueur (Figure 2). The newspapers around the table are fragments of news and political opinions, leading art historian Patricia Leighten to interpret the artwork’s meaning: “[Picasso] is presenting the reader/viewer with the kind of heated discussion that would be going on in a Parisian café.”⁵ Picasso uses media from his daily life—newspaper

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clippings—to reflect on situations from his daily life at the café. Picasso sometimes uses clippings with words written by his friend, the poet Guillaume Apollinaire, participating in the activity of artistic sampling by curating what text is shown. This activity is made possible because of the introduction of mass-produced disposable media; the surplus of newspaper allows it to be cut up freely as a cheap art material.


Picasso’s technique of involving external media in his paintings proliferated. One year later, Ukranian-born Parisian transplant Sonia Delaunay (1885-1979) created the breathtaking *La Prose du Transsiberian et de la Petite Jehanne de France* (“The Prose of the Transsiberian and of the Little Jeanne of France”, 1913) which mixed watercolors, maps, colored text, and other paper media into a two meter

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long illustrated poem (Figure 3). Delauney uses this assortment of media “in order to evoke the prismatic simultaneity of modern life.”\(^7\) By using ten fonts in different colors, Delauney exposes how stylistic parameters of communications media can have artistic impact. By using a piece of a railroad map, Delauney uses familiar daily tools as a way to tell a story.

**Futurist Approaches**

Picasso and Braque were not the first modern European visual artists to collage; earlier in the year of 1912, the Italian artist Gino Severini (1883-1966), declaring himself a Futurist, glued sequins to one of his artworks.\(^8\) The Futurists of Italy, like the Impressionists of France before them, were concerned with radically re-evaluating art for their period in time. (Perhaps an interest in the Parisian avant-garde influenced the Futurists’ decision to publish their first manifesto in Paris’ *Le Figaro* magazine.) In one of many Futurist essays, Carlo Carrà (1881-1966) describes how his art is guided by “a love of modern life in its essential dynamism – its sounds, noises, and smells.”\(^9\) The “Manifesto of Futurist Painters,” collectively written by many Futurist artists, expresses similar concerns:

> Living art draws its life from the surrounding environment. Our forebears drew their artistic inspiration from a religious atmosphere which fed their souls; in the same way we must breathe in the tangible miracles of contemporary life.\(^10\)

\(^7\) Foster et al, “1913,” *Art since 1900*, 122.  
\(^8\) Ibid., 112.  
As examples of these miracles, the authors list “the iron network of speed communications which envelops the earth,” “transatlantic liners,” and other industrial subjects which were new aspects of urban life. Luigi Russolo (1885-1947) was guided by these concerns when he incorporated the sensations of daily life into his art through his noise instruments, the Intonarumori, which he began building in 1910. Russolo treats daily life’s sounds as material to collage with, much as Picasso and Braque treated the daily newspaper in 1912.

Readymade Forms

This approach to life’s raw materials in modernism also reached the young Parisian artist Marcel Duchamp. Duchamp’s early contributions to cubism indicate his participation in an artistic dialogue with Picasso and Braque, but it was his rebellious “readymades” that constitute the beginning of his unapologetic use of everyday life as a subject. Readymades such as Bicycle Wheel (1913) consist of mass-produced objects, with very little modification, displayed as art in a provocative gesture (Figure 4). He writes, "In 1913 I had the happy idea to fasten a bicycle wheel to a kitchen stool and watch it turn."¹¹ This technique became known as a readymade, the forerunner to the assemblage.

Bicycle Wheel is an extension of what Picasso and Braque started; barely one year after Picasso began gluing objects to his paintings, now the painting was no longer present at all, only objects and glue. If a clipping from the newspaper can constitute a majority of a Picasso artwork, why cannot the newspaper itself be an artwork? Duchamp’s actions extend, also, the notion found in Picasso of the artist as

¹¹ Marcel Duchamp, “Apropos of Readymades,” Art & Artists (vol. 1, no. 4, July 1966), 47.
curator. In a defense of his readymade *Fountain*, published in the Dada magazine *The Blind Man*, Duchamp writes, “Whether Mr Mutt with his own hands made the fountain or not has no importance. He CHOSE it. He took an ordinary article of life, placed it so that its useful significance disappeared under the new title and point of view—created a new thought for that object.”¹²


In his later career, Duchamp traced the logical repercussions of his readymades. If industrial objects and mass-produced media could be repurposed as art, so too could mass-produced art and art reproductions. His series of works titled *Boîte-en-valise* from 1935 to 1942, in collaboration with Joseph Cornell (1903-1972), are exquisite examples of early artistic sampling (Figure 5). In many ways they are

¹² Marcel Duchamp, Defense of Fountain in “The Blind Man,” in *Art Since 1900*, 129.
like readymades: Duchamp contributes the form in which old content is presented and arranged, instead of contributing new content. In the case of Boîte, he cleverly uses his prior artworks as the media to arrange, treating his own art as a readymade.

Duchamp came to be affiliated with Dada, a sibling movement to Futurism arising in Zurich in 1916. Dada member Georges Hugnet (1906-1974) writes of its “deliberately and continuously subversive attitude, their construction of paintings and objects out of elements entirely foreign to art, borrowed from everyday life and from nature.”13 Through the lens of Dada, Duchamp’s rebellious actions advocate for an elevation of the banal and everyday into art.

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Summary

The subversion of contemporary life’s materials by Picasso, Duchamp, Futurism and Dada contributed to the present consistently taking center stage as their subject matter. The work of these artists set the stage for mid-20th-century art movements: the pop art of Andy Warhol (1928-1987), who elevated the simplest activities of life to the pedestal of art; the nouveau realisme of Yves Klien (1928-1962); the junk assemblages of Robert Rouschenberg (1925-2008); any artist who looks to the materials and media of their daily life as a subject and a source of form. The perspective of modernist Paris, Milan, and Zurich—that art should be re-evaluated for every new generation, and that it can use the most contemporary of materials—makes it a valuable perspective for any era. As Hugnet writes, Dada is not a form or style of art, it is a way of reacting to the world: “Dada is not modern and even less modernistic; Dada is always a thing of the present.”

Media as Instruments

At a Dada event in Berlin in 1920, the young composer Stefan Wolpe (1902-1972) turned on eight gramophones and performed by controlling their speed. Analyzed in reference to the collage and assemblage aesthetic that arose across Europe in the decade prior, Wolpe’s performance can be seen as the presentation of gramophones and records as readymades which are active rather than passive. Like

Picasso and the newspaper, Wolpe uses artifacts of communications media as artistic material. Rather than borrowing music through transcription, as Béla Bartók or Igor Stravinsky might, Wolpe presents the records themselves in a new context.

One year later in Weimar, Wolpe’s creative approach to gramophones was codified by László Moholy-Nagy (1894-1946) of the Russian Constructivist movement. His 1921 essay “Production – Reproduction” urged artists to use communications media not as a way to reproduce content, but as instruments for creative production.16 Moholy-Nagy cites gramophones and cameras as potential tools which could be used creatively. Moholy-Nagy recognizes that different media cannot be treated equally; each is a source of unique types of content and interactions. Of the phonograph and camera, he contends, “This calls for a profound examination ... What is this apparatus (instrument) good for? What is the essence of its function?”17 He theorizes potential processes for making new music with phonographs: perhaps a human could draw waveform grooves into a wax cylinder by hand instead of imprinting the sound of other instruments through recording technology. Moholy-Nagy understands that to make use of new media for creative production, the artist must critically reevaluate what kind of content they expect to create, and how they expect to do it. For Moholy-Nagy, new forms of content must be extracted from the material of the medium through a process of careful experimentation.

Aspects of this material-driven philosophy were furthered by Marshall McLuhan (1911-1980), the Canadian sociologist whose broad studies of

17 Ibid.
communications media in the 1960s first brought the term “medium” into its current use in technology. In *Understanding Media*, McLuhan notes how different media afford different content. He illustrates this by noting how the same message passed through different communications media will be perceived differently, such as how the 1960 presidential debates were perceived differently by those who witnessed it by radio (audio only) versus those who witnessed it on television (audio and image). In this way, media shape their content by creating boundaries for what can and cannot be communicated.\footnote{Marshall McLuhan, *Understanding Media: The Extensions of Man* (New York: McGraw Hill, 1964), 20.}

McLuhan and Moholy-Nagy shift our attention from the content of art to the medium of art. Their writings, along with the formalist and constructivist artworks of modernism, assert that the characteristics of a medium affect its content in several ways. Three of the most significant traits of a medium that affect its content will be described here as *ancillary content*, *formal affordances*, and *tangible affordances*.

In order to define these three terms, consider Twitter, a social media platform founded in 2006, as an example. In Twitter, a written message is communicated as a tweet (Figure 6). However, a tweet contains more content than the text message that is sent; it contains profile images, buttons, icons, additional

Figure 6: A tweet.
text, a background, and a border. These are ancillary content, extra content that the Twitter medium adds to frame its messages. The Twitter medium also controls its content with rules about what content it allows, such as only allowing 140 text characters per message. This is an example of a formal affordance, a rule which dictates what information can travel through the medium. Finally, a tweet can be interacted with. It can be embedded in a website, “retweeted,” or printed and cut in half. It can be written using a keyboard or it can be algorithmically generated using the Twitter API, as a Twitter Bot would do. These are examples of tangible affordances, actionable materials or devices through which a message can be created, modified, or destroyed.

In the decades leading up to the media art movement of the 1960s and 70s, several artists’ and composers’ works explore these three aspects of media. Conceptual works by John Cage (1912-1992) and Robert Rauschenberg explore the ancillary content of media. Instrument builders—acting in the tradition of Russolo—blur the boundaries between an instrument’s formal affordances and a composition. Finally, a new generation of artists arises who, in the spirit of Moholy-Nagy, work directly with the tangible affordances of communications media to create new works.

The Ancillary Content of Media

John Cage’s attention to the ancillary content of a medium guided many of his most significant works. His composition 4’33” (1952), which asks the performer to not play any sounds, can be viewed through this lens. Rather than using a concert event to reproduce a Beethoven symphony, he looks to the concert hall medium
itself as a source of sound. The concert hall, traditionally a medium for reproducing music, becomes an instrument. The content of 4'33”, then, is the ancillary sound of the concert hall: ambient audience noise.

In dialogue with Cage, and arriving before 4'33”, Robert Rauschenberg’s *White Paintings* (1951) are an application of similar ideas to painting. A series of canvases painted white, the *White Paintings* nonetheless have content: they have a shape and size, they contain blemishes that create subtle pieces of form, and they receive the shadows of the art gallery. Like 4'33”, the *White Paintings* focus our attention on the unintended content which the medium of paint and the medium of the gallery add to a work of art. Rauschenberg makes ancillary content the central content of his *White Paintings*.

Rauschenberg and Cage demonstrate that a medium has content of its own. Both artists elevate their medium’s ancillary content by reducing the artist’s contribution to silence or non-action. In doing so, they establish a precedent for accessing ancillary content through presenting empty media: an empty tweet, a silent record that only crackles and pops, or an empty web browser that shows only navigation buttons and a scrollbar.

**The Formal Affordances of Media**

Of the Futurists’ contributions to modernism, Luigi Russolo’s *Intonarumori* hold special significance for composers of 20th-century music. In addition to his pursuit of noise, Russolo’s ethos of invention is especially important. It is not any specific composition by Russolo, but instead the formal affordances of his newly invented medium, the *Intonarumori*, which contain his message: that of noise,
rebellion, and an attention to the sounds of daily industrial life. Russolo reveals instrument-building as a vital compositional component in its capacity to set the boundaries of what sounds can and cannot be created. Russolo shows how new instruments are ways of accessing new content through new formal affordances. For Russolo, designing a new medium became a powerful compositional gesture.

A musical instrument is a type of medium, a communication intermediary that sets the boundaries of what can and cannot be made. To McLuhan, these limits of expression have, in themselves, their own meaning or message. It is this message that many artists approaching media in the experimental tradition explore. New media are approached as instruments with their own formal boundaries, unique tendencies, and natural types of content.

The Tangible Affordances of Media

When approaching a communications medium as an instrument, Moholy-Nagy emphasizes taking advantages of the tangible affordances of a medium. In his description of drawing audio waveforms directly onto the wax cylinders of a gramophone, he elucidates a practice which has dominated the media arts: using unorthodox and often hands-on interactions with the guts of a medium to reveal formal affordances which might be overlooked by the medium's intended use.

The composer Conlon Nancarrow (1912-1997) exemplifies this practice. In 1948, he began to work with a player piano as an instrument for new compositions. Instead of using the player piano to reproduce prior piano performances, Nancarrow worked hands-on with the paper piano roll, punching notes in by hand in order to create rapid rhythmic patterns that a human could not play. Nancarrow's
tactile approach takes advantages of the tangible affordances of the piano's paper piano roll to create precisely-spaced, automated note sequences. By using the unique tangible affordances of the player piano to access new kinds of content, rather than accepting it as a tool for duplicating past music, Nancarrow is a prototypical artist in the Moholy-Nagy tradition.

Pierre Schaeffer’s development of musique concrète in 1948 is perhaps the most complete precedent for engaging the tangible affordances of a communications medium. Schaeffer created his suite *Etude des Bruits* by working directly with the recording studio as an instrument. Working creatively with a disc lathe, mixers, amplifiers, filters, and other audio recording technology, Schaeffer created a new musical genre in which the studio is the location of all compositional activity, and the recorded audio disc holds the original composition, not a copy of a pre-existing musical performance.

Schaeffer’s concept of *l'objet sonore* (“sound object”) is a sign that he opened his creative practice to the studio medium and was willing to let the medium change his musical style. *L'objet sonore* is, in many ways, a sound embodied on a record, a musical motive with all of the tangible affordances of the studio medium. It is a sound that can be cut, played at different speeds or backwards, a sound with the added malleability of its embodiment. By cutting tape, handling records, or using a filter expressively, he reveals aspects of musical form that are natural to his medium.

Schaeffer’s practice of musique concrète exemplifies the extrinsic inspirations of artists in the Moholy-Nagy tradition. Schaeffer approaches the studio with the question: “How can these tools be used to compose?” Like Nancarrow, he works
directly on the medium’s material, rather than using the medium’s traditional interface to record an imprint of existing musical forms. In doing so, he reveals new potentials of the medium.

Summary

In the first half of the 20\textsuperscript{th} century, artists approached new communications media as actionable readymades, full of ancillary content and new creative affordances. Echoing Picasso’s tactile approach to the daily newspaper and Duchamp’s bold assemblages, a new generation of composers and artists viewed media as sources of inspiration, content, and form. In the content-less works of Cage and Rauschenberg, we hear instead the ancillary content of the medium revealed. In the new instruments of Russolo, we see the way that new media reveal new territories of content. In the works of Nancarrow and Schaeffer, we see a creative approach to communications media which is tactile, subversive, accurate to the medium, and motivated by production, not reproduction.

McLuhan warns of our tendency to use new media to reproduce old ideas. He notes, “We look at the present through a rear-view mirror. We march backwards into the future.”\textsuperscript{19} In this statement, he describes the challenge of reevaluating new media for their new creative possibilities, as Moholy-Nagy asks that we do. Through these artists, we see an emphasis on reimagining artistic processes to fit the new technologies and media that become available in our culture. As such, these media explorations are connected, as Picasso’s was, to the engagement with the content of

\textsuperscript{19} Marshall McLuhan and Quentin Fiore, \textit{The Medium is the Massage} (New York: Bantam Books, 1967), no page.
everyday life. As the contents of our lives are increasingly mediated by communications technologies, engaging with the form and content of these new media becomes a profound way to engage with the materials through which we live our lives.

Empirical Approaches to Media Art

Cubist and collagist Georges Braque describes how, after abandoning the goal of mimetic representation in his paintings, his creative practice became increasingly empirical and media-driven:

Every new picture is a gamble, an adventure into the unknown. It seems to me that I ‘read’ my way gradually into a canvas rather like a fortune-teller ‘reading’ tea-leaves. It is the act of painting, not the finished product, which counts. I never know how a painting is going to develop.\(^{20}\)

Braque describes an emphasis on material, and a practice of deriving content from material rather than beginning an artwork with a finished product in mind. This material-driven philosophy yields an empirical creative practice; Braque discovers a finished product through experimental interactions and in-the-moment reactions to his material and his experiences.

Through the latter half of the 20\(^{th}\) century, this empirical creative practice became codified in a movement of media artists who used their media as a starting

point. In the words of electronic media artist Nam June Paik (1932-2006), for example, we see a perspective nearly identical to Braque’s:

Usually I don’t, or cannot have any pre-imaged VISION before working. First I seek the “WAY”, of which I cannot foresee where it leads to. The “WAY” ,,,,,, that means, to study the circuit, to try various “FEED BACKS”, to cut some places and feed the different waves there, to change the phase of waves etc...

This philosophy is evident in Paik’s television assemblages such as Magnet TV, shown at his 1963 exhibit “Exposition of Music – Electronic Television” (Figure 7). Described by Paik as a “prepared television,” a nod to the prepared piano of John Cage, the work shows Paik experimenting with the physical components of a television—in this case, placing a magnet on top—to discover new forms of content native to the medium.


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Paik exemplifies a resurgence of interest in the assemblage and subversive approaches to everyday materials in America in the post-war period. The 1951 publication of Robert Motherwell's anthology *The DADA Painters and Poets* led to a new generation of American artists with greater access to Dada's ideas. Duchamp had relocated to New York by that time, and John Cage—in many ways a proto-Dadaist—was exerting increasing influence in the art world through the publication of his book *Silence* in 1958 and through his students at the New School who were beginning to impact the art world on their own.

This new movement contained unmistakable traces of modern Paris. Wolf Vostell (1932-1998)—the originator, with Paik, of television installation as an art form—called his first exhibit *6 TV Dé-coll/age*, framing his work in the context of the collage genre. Rather than using *collage* ("gluing"), Vostell uses *décollage* ("ungluing"): beginning with an existing media object and deconstructing it. Later, a magazine devoted to the Fluxus performance art group similarly adopted "De/coll-age" as its title.

In the 1950s, with the genres of media art and cut-ups, artists approached media as instruments for generating new types of content. For these artists, the creative act was the exploration of all a medium's affordances and physical qualities. In doing so, they demonstrate the lingering effects of modernism and the power of the modernist perspective to stay contemporary even through changing technologies. Furthermore, in their use of communications media as affordant creative tools, these artists reveal a creative practice that is thoroughly empirical, driven by experimental interactions with new media which are both conceptual and tactile.
Tactile Approaches to Paper and Film

In the years after Pierre Schaeffer’s development of musique concrète, artists applied the collage aesthetic to paper and film media. The novelist William Burroughs (1914-1997) approached his novels with a razor blade, and, like Schaeffer, Burroughs was inspired by visual artists and modernist collage. In his essay “The Cut-Up Method of Bryon Gysin,” Burroughs relates how the British-Canadian painter Brion Gysin (1916-1986) told him “writing is 50 years behind painting”. Gysin, staying at a “beat hotel” in Paris, proceeded to cut up some text and rearrange it (see, as an example, Figure 8). Later, Burroughs would cite Dada members André Breton and Tristan Tzara as precedents, and adopt the technique for his “cut-up novel” The Soft Machine (1961).


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Two years later, the video artist Stan Brakhage (1933-2003) also began circumventing traditional uses of his medium, film. Instead of using a film camera in its normal mode—to record events, he worked hands-on with the film tape itself. For *Mothlight* (1963), Brakhage taped real moth wings onto the film, along with other natural items (Figure 9). The film is played back as normal film would be, through a film projector. Each detailed and visually unique film panel is seen for only a moment, resulting in a rapid time-based collage of these different fragments. In this action, Brakhage subverts the standard film medium. Rather than using film to record life, Brakhage puts real pieces of life through the film projector.

![Figure 9: Stan Brakhage, Film strips from *Mothlight*. 1963. Source: Walker Art Center, http://walkerart.org (accessed May 23, 2016).](image)

In other film works, Brakhage paints directly onto film. The practice is conceptually similar to *Mothlight*: by working hands-on with film, and making each film pane unique, he reveals film’s capacity to create a detailed collage over time. In
both cases, Brakhage takes his medium apart, touches the film, and changes it. His interactions with film are direct.

Electronic Assemblages

Paik’s work with television and electronic media in the early 1960s exhibits a similar attention to the formal affordances of a medium. Speaking of his work using televisions, Paik writes:

I ... envisage the day when the collaboration of artist and engineer will progress into the unification of artist and engineer into one person ... We have, in color TV, 12 million dots per second, which I have somehow to control for my work. It is like composing a piano concerto using a piano equipped with 12 million keys. How can you deal with that vast quantity of possibility without the painstaking study of your materials and instruments?²⁴

Paik expresses a vision for the artist as an engineer or inventor, guided by experimentation and observation. To Paik, an artist should be guided by the affordances of a medium and carefully observe its boundaries and inclinations.

According to my past experience, the best results were achieved through accident and error. ... Therefore, if I give an order to an engineer, and if I don’t go through all the experiments myself (that is, the complicated process of trial and error), I will lose all these precious errors, I will only get what I want, and miss all the disappointment and surprises. I have found that the by-product is often more valuable than the first envisioned aim.²⁵

Paik applies these concepts not only to television but to a variety of media. In Random Access, part of his 1963 show, Paik affixes audio tape to a wall of the gallery

²⁴ Nam June Paik, “Interview with Jud Yalkut”, Arts Magazine (April, 1968), 51.
²⁵ Ibid.
and offers the read-head of a tape player to the gallery attendees (Figure 10). Viewers scrub the read-head along the tape, sonifying different pieces of it. Like Brackhage, Paik treats the audio tape as physically malleable. He deconstructs a traditional medium to create a new electronic configuration which affords new types of creative input by the audience.


**Sound Assemblages**

Paik shows how, as a collagist—or as an artist acting in the Moholy-Nagy tradition—different disciplines of art can be approached with the same perspective. In *Random Access*, he is able to approach electronic audio media with the same
perspective that he approaches electronic visual media, because each is just that: electronic media.

At the San Francisco Tape Music Center, Steve Reich (b. 1936) participated in the development of new configurations of audio media and exposes them as sources of musical form. In *Pendulum Music* (1968), microphones hang over speakers and are swung like pendulums. The movement back and forth creates rhythmic feedback with the speaker on the floor, which is pointed upward towards the moving microphone. Like Cage and Rauschenberg, Reich adds no content to the work. Instead, the room's acoustics determine the pitch of the feedback. The content of the work is made entirely with what would normally, for a rock band, be considered the medium: the electronic tools and acoustic space that a song travels through to be amplified and projected to the audience.

This perspective carried on into the 1980s in the vinyl records experiments of Christian Marclay (b. 1955). Marclay works hands-on with vinyl records, cutting records into pieces and gluing pieces back together to recreate a new record made of several different parts (Figure 11). The resulting record has a visual aesthetic as well as an auditory aspect. Marclay's technique borrows from collage, like Schaeffer does; Marclay's records are assemblages of physically mediated audio information. In another work, *Record Without a Cover*, the scratches that occur on a record—as it is travels by being bought and sold—are the only sonic content of the record. In *Footsteps*, gallery viewers walk on records, the imprints of the footsteps then becoming the sonic content of the records. All of these methods reflect Moholy-Nagy's ideas as significantly as Schaeffer's work. Marclay uses vinyl records, which
are intended to reproduce the sounds of an orchestra or other ensemble, and interacts with them directly as a mode of production.


**Summary**

Paik is describes as “freeing the medium from its limited corporate and technological yoke.” He and other media artists of the 1960s rigorously subvert commercial media which would traditionally be used for content reproduction. These artists share motivations with the collages, assemblages, and readymades of early modernism. In 1910s Paris, collages and assemblages were made out of industrial materials which were suddenly plentiful; in the 1960s, media artists used mass-produced electronic media which was suddenly disposable. Newspapers were

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plentiful for Picasso, TVs were plentiful for Paik, and vinyl records were plentiful for Marclay. The empirical approach described, then, is not concerned with devising expensive new technologies. Rather, it aims to subsume plentiful daily media into the practice of assemblage and collage by exploring these media for their artistic affordances as sources of production.

Network Forms

In the latter half of the 20th century, networked electronic media became increasingly plentiful and were assimilated into the empirical media art practice that arose after modernism. New networked art forms followed, delivering on the promise of McLuhan and the Futurists (who had already described making art from “the iron network of speed communications which envelops the earth”). Networks in early electronic art arose in reaction to several different types of media: circuitry, telephones, radios, and television. Networked art demonstrates how the philosophies of Moholy-Nagy, Duchamp, McLuhan, and Paik are updated for the connectedness which dominated the 80s, 90s, and 00s, even if its roots are in the telephone lines and circuits of the 1950s and 60s.

Circuits as Networks

In a promotional flyer for a 1965 exhibit of television art, Paik declares: “Someday artists will work with capacitors, resistors & semi-conductors as they work
today with brushes, violins & junk.” Paik foresaw this transformation because he had one foot in the electronic music world, where that era of home-crafted electronics had already begun. In fact, one of the performers in Paik’s 1964 New School show “Electronic TV & Color TV Experiment” was 27-year-old experimental composer David Behrman (b. 1937), who Paik met at the 1959 Darmstadt International Summer Course in contemporary music. Within 2 years of Paik’s show, Behrman would form the Sonic Arts Union and tour the United States with the SAU’s unique brand of musical homemade electronics.

In 1975, Behrman began teaching at Mills College, the new home of the San Francisco Tape Music Center. By 1977, he had started a small networked circuit ensemble that included students and bay area musicians (Figure 12). The group named itself the League of Automatic Music Composers (LAMC) due to their reliance on the automation of circuits to co-compose. The group is notable also for its reevaluation of the musical instrument, creating collaborative instruments using networked circuitry.

Behrman’s formative involvement with this group traces a direct line from the LAMC’s networked circuitry back to Paik’s media art and the empirical perspective originating in early modernism. LAMC member John Bischoff (b. 1949) expresses how the group looked outward to their electronic materials in an attempt to accept what music happened, without expectations or presumptions. Referring to Audio Wave (1978), a networked composition for digital KIM-1 microprocessors, he writes:

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The nature of this voice is shaped by the limitations of the KIM-1 medium and my response to them. The sound of this voice is the vibratory work of a speaker cone used as an instrument. It does not rely on simulation of acoustic instruments for its musical effects. Rather, it seeks its own musicality in properties discovered within the electronic system itself.\(^\text{28}\)

Bischoff explains his openness to reevaluating artistic results based on the medium he is working with. The reality of that medium—not a specific sound that is intrinsically inspired in the composer—is the guiding force behind his music. He concludes, "My view emphasizes the empirical nature of musical invention, an

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embrace of the humanly and physically actual, imperfections and all, as a source of musical richness.\textsuperscript{29}

Bischoff cites many past artists for instilling this perspective in him, chief among them David Tudor (1926-1996).\textsuperscript{30} Among Tudor’s many custom-designed electronic works in the 1960s, his series of \textit{Rainforest} performances from 1968-73 are especially relevant. In \textit{Rainforest IV}, sound transducers are affixed to a group of real-life objects. Different sound sources are played into each transducer, and the transduced objects act as flawed resonant sounding boards for the sound source. Each object becomes a filter which affects the audio signal passing through it. The resulting sound of each object is sent as an audio stream to other objects, creating an interlinked ecosystem of sound controlled by a central mixer.

\textit{Rainforest IV} is a key antecedent to Bischoff’s perspective for several reasons. Much like in Paik’s television exhibitions 10 years earlier, Tudor creates an electronic configuration which has activity all its own. The audio content that is sent into the system is not the composition, in fact Tudor used different content for different performances. Instead, the configuration is the composition, the source of musical interest. Secondly, the work is an assemblage of junk and media. Linking together a collection of real-life objects, contact microphones, transducers, and wires, Tudor creates a hybrid assemblage-instrument. Additionally, Tudor explains how he is engaging with Moholy-Nagy’s ideas by giving voice to audio reproduction media:

\textsuperscript{29} Bischoff.
\textsuperscript{30} Ibid.
My piece, Rainforest IV, was developed from ideas I had as early as 1965. The basic notion, which is a technical one, was the idea that the loudspeaker should have a voice which was unique and not just an instrument of reproduction, but as an instrument unto itself.31

Finally, Rainforest IV is a network. Two key components of the circuit are the penultimate nodes on each end of the schematic (Figure 13). These nodes, labeled, “Mix, Distribute,” are opportunities to connect each object to other objects. Through this flexible system of connections, audio travels around a network of objects.


Both the LAMC and Tudor take empirical, material-first approaches to circuitry and speakers as artistic tools. In doing so, both artists reveal the circuit as a network. By considering the network an autonomous agent and collaborator, these artists continue the trend of shifting attention away from composed content and

onto the medium as a source of content. Furthermore, they reveal the network as a form capable of new artistic possibilities.

**Telephones as Audio Networks**

While electrical networks can be made locally, as in the works of Tudor and Bischoff, they can also spread across great distances. Remote and telematic network communication emerges from the form of electronic circuitry. Concurrent with Tudor’s conception of *Rainforest IV*, Maryanne Amacher (1938-2009) and Max Neuhaus (1939-2009) looked to an existing electronic network—phone lines—as a new art medium with new formal affordances.

Amacher’s *City Links* is a series of 22 installations, beginning in 1967, in which live audio streams from distant areas are sent through telephone lines to a central mixing console in an art gallery. Often, distant cities are connected in this way, their sound environments merged. Amacher writes, “I was particularly interested in the experience of ‘Synchronicity’, hearing spaces distant from each other at the same time, which we do not experience in our lives,” revealing that Amacher was looking to the unique abilities of the telephone as musically valuable. Often, Amacher notes, sonic activity happened suddenly in two places at once, placing the distant spaces in counterpoint. Other versions of *City Links* combine spaces with similar acoustic attributes, such as when she links a Rent-A-Car store with the central art space, which had identical resonant frequencies and reverb levels. Listeners could not

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34 Ibid.
distinguish the sound of one site from the other, leading to ghostly echoes and footsteps.

Amacher uses the telephone system not as a way to distribute music, already pre-formed, but as a way to access and control individual sounds as components of a composition. Amacher, like Moholy-Nagy and Schaeffer, uses a distribution medium as an instrument with its own creative affordances. In addition, she opens her creative practice to the capabilities of the phone: “The adventure is in receiving live sonic spaces from more than one location at the same time - the tower, the ocean, the abandoned mill. Remote sounding environments enter our local spaces and become part of our rooms.” Amacher frames her work with telephones as an adventure, and describes the excitement of hearing remote sounds brought into one's own personal environment.

In 1966, Max Neuhaus also looked to existing networked audio media as a sources of form. For Max Neuhaus's sound artwork *Public Supply* (1966), Neuhaus wired 20 phone lines into a radio station. People could call in and he would mix their audio stream and broadcast it on the radio, creating feedback. Of the inspiration for this work, Neuhaus remarks, “I realized I could open a large door into the radio studio with the telephone; if I installed telephone lines in the studio, anybody could sonically walk in from any telephone.” Like his predecessors, Neuhaus embraces the everyday sounds of noise and speech, and uses communications media as instruments.

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35 Amacher.
Radio as a Form

The use of radio in music and art has a long history. In one of its earliest creative uses, *Imaginary Landscape No. 3* (1943) John Cage took apart a radio and attached its antenna to the head of a phonograph. *Imaginary Landscape No. 4 (March No. 2)* (1951) for 24 performers playing 12 radios was a new height, as the radio was the only instrument on stage. But to Cage, the radio merely a sound source; he does not mines the depths of its formal characteristics any farther than that.

In contrast, Karlheinz Stockhausen's (1928-2007) approach to the radio is a fuller embrace of the radio for its formal and conceptual qualities. In 1968, Stockhausen debuted *Kurzwellen* as the exposition of his conceptual approach to radio. Written for an ensemble of four players each with an instrument (viola, piano, tam-tam, electronium) and a shortwave radio receiver, *Kurzwellen* instructs performers to make radio “events” that are then listened to, imitated, and developed by the ensemble.

In *Kurzwellen*, Stockhausen engages with several formal aspects of the radio, and lets these aspects guide his compositional processes. He describes his process:

...when you become like what I call a radio receiver, you are no longer satisfied with expressing yourself, you are not interested in yourself at all. There is nothing really to express. Then you will be amazed at what happens to you... You become a medium.37

*Kurzwellen*’s radio ensemble can be seen as an embodiment of the creative act, an environment in which sound is freely received, transformed, and projected. The radio, to Stockhausen, is a medium whose form parallels the imagination. In

*Kurzwellen*, performers listening to it as a source of material as if they are
Stockhausen transcribing sounds from his mind.

In addition to being a metaphor for the creative act, Stockhausen views the
shortwave radio as a meta-instrument that contains fragments of music inside itself.
When a player scans his or her radio, extra snippets of music pop out and become
material for future events. Stockhausen uses preexisting material to create new
music and the radio as a generative tape, an automatic writer, a sort of infinite
version of Duchamp's *Boîte-en-Valise*.

Of the early era of network it art, it may be the radio work of Filipino
professor Jose Maceda (1917-2004) that is most insightful and enduring. His 1974
composition *Ugnayan* broadcast a 24-channel composition using all active radio
bands of a city in the Philippines. All residents of the city were encouraged to take
their radios out into the streets and explore the radio stations collaboratively.
Maceda presents a synthesis of the approaches to radio of Cage, Stockhausen, and
Neuhaus. Like Cage and Stockhausen, Maceda uses the radio as an instrument to
access sounds and noise, a meta-instrument with artifacts of sound inside it that
can be collaged. Like Neuhaus, Maceda creatively takes advantage of the radio's
ability to broadcast.

Maceda's uncommon ability to commandeer all stations of a radio, and to
organize the actions of an entire town, are crucial to the success of the piece. But in
performing *Ugnayan* once, Maceda established a formal precedent for the use of an
audience's electronic devices as speakers, a paradigm which has now become
known as *distributed music*. This idea of distributed music has been adopted by
audience participation concerts using mobile phones. The first of these is
considered to be *Dialtones: A Telesymphony* (2001) by Golan Levin (b. 1972) and eight collaborators. In *Dialtones*, stage performers dial audience members’ phone numbers to activate their cell phone ringtones in an organized composition.

While a work like *Dialtones* appears to be a new and novel event, it can be evaluated as just another application of past, modernist concepts to the present. It exhibits Moholy-Nagy’s philosophy of being creative with a communications medium (the cell phone). It exhibits *fin-de-siècle* Paris’ use of materials and sounds of daily life (cell phone ringtones). It exhibits Picasso’s notion of collaging media artifacts. Finally, it exhibits the notion of instrument invention as a way of accessing new possibilities, as demonstrated by Russolo.

**Summary**

By exploring existing networked media, these artists reveal the artistic potentials of networks. In doing so, they show that each type of networked media--radio, telephones, circuitry—provides its own opportunities. Maceda is able to turn a whole city into a speaker system because of the radio’s wirelessness. Following in the media art tradition, these artists react to the formal possibilities of new media in order to create new genres, demonstrating how the empirical approach of media art can be applied to networks and contemporary media of any age.
Dada member Hugo Ball writes, "For us, art is not an end in itself ... but it is an opportunity for the true perception and criticism of the times we live in." In its spirit, the media art practice of the 20th century is powerful because it can be equally applied to new eras. It is no surprise, then, that a collection of equally-minded artists continued that tradition into the 21st century, applying it to the dominant media of our day: the internet and the web browser.

Hugo Ball's characterization of Dada is an apt descriptor of the perspective of JODI, the duo of Dutch and Belgian artists who launched what many consider to be the first website of the “net.art” movement: jodi.org (Figure 14). Rather than using


the website to display their art, JODI created a website which was a work of art itself. Although web browsers were not capable of many types of audiovisual processing in 1995, JODI recognized that the browser itself has ancillary content that can be the subject of artworks. For example, with one line of JavaScript, a `window.open()` command creates a box with shape, color, and iconography. These aspects of the browser became flexible material for JODI as they embraced the web’s low-fidelity imagery and the formal tendencies of the web’s languages: HTML and JavaScript. Often, the subject of JODI’s net.art is the materials we look through to get to our digital information: HTML, digital maps, the animation of downloading a file, the imagery of the computer desktop.

By opening several browser windows and arranging the content of the web, JODI creates an artistic product very similar in scope to Picasso’s newspaper collages. However, unlike a newspaper, the digital artifacts of a website cannot be touched or cut with scissors. Just as Paik turned to the circuit in order to subvert the medium of his era (television), so JODI turns to computer programming in order to subvert the dominant medium of their era, the web.

Through creative computer programming, net artists like JODI subvert internet media in ways that reveal many connections to modernist practices of assemblage and media art. With the browser’s additional properties as an interactive networked medium, artists and composers also take advantage of its capacity to organize networks of participants, extending the history of earlier approaches to networked media.
Creative Code

The practice of artistic computer programming, or “creative code,” has a history in the 1970s and 80s which actualizes the unification of artist and engineer that Paik foresaw in the early 1960s. With these connections across decades, many elements of creative code can be seen not as an anomalous phenomenon of the 21st century, but as an extension of the empirical media art practice of the mid 20th century.

In the 1975 anthology *Artist and Computer*, one sees evidence of this unification of artist and engineer, such as when Karen Huff begins a phrase saying "As both a handweaver and a computer scientist..."39 Similar to how Paik writes about resistors and capacitors being a new form of artist’s brush, Ann Murray muses:

A. Michael Noll has predicted the development of special “programming languages” which could be geared to the requirements of any individual artist, and which would eventually become "as natural to use as the conventional brushes and oils." If Noll is correct, and if more and more artists learn programming techniques in order to realize their ideas directly without the programmer as middleman, the concept of a bona-fide computer-based “scientific aesthetic” may begin to seem less foreign.40

Murray’s notion of a ‘scientific aesthetic’ reveals her view that the use of computers for art should be guided by the computer’s computational abilities, not simply a projection of past ideas onto the computer.

Edward Ihnatowicz defines his vision for computer art in a neighboring essay, noting, “[computer art] distinguishes those artists whose inspiration comes from outside the world of computing and who use the computer simply for convenience from those whose ideas have originated as a result of computing experience.” Ihnatowicz here splits creative code into two schools: those who use the computer as a means to an end, and those who derive their inspiration directly from the computer. In describing this latter group—computer art—as reactionary, a “result of computing experience,” Ihnatowicz places artists like JODI firmly within the empirical media art tradition, a reflection of “those aspects of nature which the current technology make accessible.”

**Net.art as Assemblage**

JODI and other artists in the net.art genre used creative programming of websites to engage with the web browser’s core materials. In Mark Napier’s (b. 1961) *Shredder* (1998), the artist uses creative code to turn existing websites into a collages (Figure 15). The *Shredder* website divorces the content of a website from its intended form, revealing the raw materials of a site and framing them as art. Napier writes:

> The current thinking of web design is that of the magazine, newspaper, book, or catalog. ... The Shredder presents this global structure as a chaotic, irrational, raucous collage. By altering the HTML code before the browser reads it, the Shredder appropriates the data of the web, transforming it into a parallel web.

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Peter Traub's (b. 1974) *Bits & Pieces* demonstrates a similar perspective as it scans the web each morning for audio files, then uses creative code to rearrange those audio fragments into a sound collage. Traub writes:

I wanted to create a piece that created a bit of an audio snapshot of the web at the time by searching for sound files... I tried to make it very general in its searches, so that it didn't look for particular types of sounds or music but rather just "sound file" or "music aiff", etc. What resulted was a piece that has run for over ten years now, and as search engines have come and gone and as the nature of sound on the web has changed dramatically, so has the output of *bits & pieces.*

Traub’s work contains echoes of its predecessors: like Duchamp, he contributes form, not content; like Levin's *Dialtones,* Traub uses sounds that are already within the medium. (In the 1990s, many of the sounds on the web were website

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44 Peter Traub, Interview with the author, 2009.
background music or sound effects.) Traub writes that he views *Bits & Pieces* as similar to Cage’s *Imaginary Landscapes for 12 radios*: “Depending on when/where that piece was performed, the content could vary completely.” Traub and Napier use formal deconstruction as a way to reveal the raw materials of the medium in a new context.

Other net artists take a different approach to the browser; rather than removing form to reveal content, they remove content to reveal form. HTML has been explored for its purely formal qualities in several works, as far back as Alexi Shulgin’s [*Form Art* (1997)](http://www.c3.hu/collection/form/) and Jan Robert Leegte’s [*Scrollbar Composition* (2000)], and as recently as Rafaël Rosendaal’s *Abstract Browsing* (2015). By using scrollbars and radio buttons as flexible material, Shulgin reveals HTML as a source of visual content, in addition to being a medium to convey content (Figure 16). In *Abstract Browsing*, Rosendaal shows us that we look through complex HTML structures to receive content on the web (Figure 17).

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45 Traub.

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These artworks further develop JODI’s notion that artworks can be made with a browser's native materials through collage and décollage. In addition, just as Pierre Schaeffer composed by working directly with the studio, internet artworks such as jodi.org, Shredder, and Form Art offer a standard through which artists can work directly with browser technologies to create art.

The Affordances of Browsing

In addition to working with the visual materials of the web, artists have worked with the affordances of the browser, its networked structure, and the act of browsing. Traub's ItSpace (2008) repurposes a social network as an open-form composition, creating a social network of sounds. The piece subverts an existing medium, MySpace, which at the time provided a social network for musicians in which individuals could connect with other musicians via “friend” status and browse

songs via hyperlinks. In ItSpace, visitors to the site are asked to record the sound of a household item, then create a profile for that item. Browsing the sounds of this sonic social network becomes a way of composing.

ItSpace fits with Moholy-Nagy’s vision of using a distribution medium as an instrument. In 2008, MySpace was one of the largest social networks in the world and the premier way for bands to distribute songs online. Traub, seeing the way that songs were browsed by hyperlinks in MySpace, considered how this act of browsing was actually a creative musical action in itself. By replacing finished songs with individual sounds, Traub clarifies the compositional affordance of browsing.

Summary

Beginning with the subversive art of modernism, a creative protocol arose in the 20th century in which new communications media were repurposed as instruments for creative production. In the 1960s, Paik and his contemporaries show us how unconventional interactions with new electronic media reveal their capacity as sources of content. In the 1970s and 80s, Stockhausen, Amacher, and others approached networked communication systems as musical instruments, composing new works in which form and content are derived from the network configuration. Artists of these eras recite, in their own words, a creative dialogue with their media, a perspective in which they are guided by the inherent content of their media more than by pre-conceived ideas. Through an experimental approach to new media that is often tangible and subversive, these works of art reposition the artist as a creative engineer who engages with the inner workings of electronic media in order to reveal their capabilities for artistic creation.
Since the 1990s, a new generation of artists have applied the same perspective to the web, confirming that this creative protocol maintains the capacity to be used with contemporary forms of media, as well as future ones. It is this capacity which keeps this creative practice relevant as a means for new generations to investigate the materials of their daily lives, and to reflect on the media through which our daily information travels. These media hold the content of our lives; revealing their forms is another way of expressing our life's content.
2. MCLUHAN.JS

McLuhan.js is an art toolkit which reflects on the web browser as a source of form and content. The toolkit enables short phrases of JavaScript code to control several browser windows containing HTML content, HTML5 audio and video players, Google Maps, Gifs, images, and other common internet media. This media can be mashed up and glitched into live narrative media collages through live performance. McLuhan.js provides tools for sound art using web audio and web media such as samples, synthesis, text-to-speech, and signal processing in order to put the sound of web browsing in a musical context. Collectively, these tools enable users to create audiovisual reflections on the activity of browsing.

McLuhan.js is inspired by the history of media artists who have turned media for reproducing content into instruments for generating content. In the case of McLuhan.js, the web browser, which is more commonly used as a way to view reproductions of 20th century media—such as newspapers, photos, and recorded songs—is instead used as an instrument for creating a new form of art which is native to the browser: a live collage of ancillary web content and contemporary digital artifacts.

Performances with McLuhan.js are distributed, meaning that the performance is sent live through the network to be reconstructed in the browsers of remote viewers. In the lineage of artists and composers who have worked in symbiosis with their medium, McLuhan.js seeks to be guided by experiences with the web browser. Since experience of the web browser is generally personal, often private, and since our communication patterns using the web browser are usually
remote, it is appropriate for internet art to be experienced privately and remotely, in
the natural environment of our own personal computers.

Therefore, McLuhan.js has several specific goals: to consist of familiar native
web content and desktop artifacts as much as possible, to be performed live, and to
be distributed and witnessed in remote audiences’ own personal computers. To
accomplish these goals, McLuhan.js contains a client-side library, a server, and a
performance interface. The client-side library provides an architecture for creating,
coordinating, and controlling multi-window media art in the browser. The server is a
collection of websockets which create an open communication channel for the
performer to send artistic commands to audience browsers. The interface is a live
coding environment with a collection of commands that extend JavaScript and
enable real-time internet art performance.

**Historical Connections**

By using the browser’s native capabilities—scrolling, opening new browser
windows, and loading webpages—as artistic actions, McLuhan.js echoes the past
100 years of media art. Reimagining Laszlo Moholy-Nagy’s “Production –
Reproduction” for a modern medium, McLuhan.js turns the web browser into an
instrument for creative production and live performance.

Through multiple browser windows, webpages are segmented and collaged.
Just as Nam June Paik and David Tudor used circuit experimentation to work directly
with televisions and speakers, so McLuhan.js uses creative code to work directly
with the capabilities of the browser. In the empirical tradition, McLuhan.js derives its inspiration from the browser and what the browser affords.

When a browser window is opened and closed as an artistic action, or when 16 browser windows are opened in a grid, McLuhan.js presents the ancillary content of the browser—URL bars, and the window frame—as art. Doing so echoes the empty works of John Cage and Robert Rauschenberg, and also follows the perspective of artists of Futurism and Dada who made artifacts from contemporary industrial life the subject of their art.

Through its remote performance paradigm, McLuhan.js aligns itself with the natural tendencies of the web. By being open to the structure of the medium, McLuhan.js participates in a new performance genre. Rather than marching backwards into the future, as McLuhan warns against, it marches with its eyes fixed on the present.

**Client-Side**

McLuhan.js contains a standalone client-side JavaScript library for creating art with familiar web media. The core of the library’s architecture consists of the following object constructors:

- **Wall**: An object for controlling collections of browser windows and coordinating their contents.
- **Medium**: A prototype of the common properties and methods for all media elements.
• **Manager**: Methods for managing a performance.

The remainder of the library is a collection of object constructors for several types of media which make the material of any McLuhan.js performance. These media include video, audio, image, and text media. In performance, the client-side library is the part of the toolkit that runs in each audience member’s browser. It receives commands from the server and creates media art actions accordingly.

**Architecture**

**Manager**

The *manager* is an object containing tools for initializing a performance. It creates a stack of windows to be used in the performance, pre-loads audio and video files, and initiates the audio processing tools. The *manager* also holds properties which have a global use within the library, such as the *stage*, which describes the size and location of the performance on the audience’s screen. The *manager* is instanced globally as the variable *m*.

**Wall**

The core structural concept of McLuhan.js is a *wall*, a collection of browser windows which have the same content or related content (Figure 18). If an image is added to a wall, the image is added to every browser window in that wall. This is the central way in which McLuhan.js uses a single function to affect a large number of browser windows. In technical terms, a *wall* is a JavaScript object which has a property containing its collection of browser windows, and a set of methods which
can affect all of those windows at once. These methods include adding media to, scrolling, moving, resizing, hiding or showing the wall.

A wall can be created in one of several visual arrangements, called patterns. These patterns are defined in JSON format, describing the number of windows, their size, and their location. Size is described as a percentage of the manager stage. A wall can also transform to the shape of a different pattern after it has been created.

![Figure 18: In McLuhan.js, a wall containing an image.](image)

### Media

The majority of the client-side library consists of a collection of media components that control web media such as audio, video, images, and text. These components are JavaScript constructors which create and control HTML dynamically. Media components are prototyped from the media constructor, which
is part of the core of McLuhan.js. Media elements are created in performance by calling a method on a `wall`, such as `wall.see()` to create an image, or `wall.hear()` to create an audio player. (Note: in McLuhan.js, it is impossible for a media component to not belong to a `wall`.)

When a media component is created during performance, several events happen below the surface: an HTML element is added to each window in the wall; each media component is added as a property of browser window it belongs to; each media component is given a default size and location on the page; and any arguments, such as an image path or audio path, are applied to the components. All media components share several methods: each can be resized, moved, hidden, faded to an opacity level, or deleted.

**Visual Media**

Several types of visual media can be performed with using McLuhan.js, including images, videos, maps, and other websites. The `photo` media component creates an image that can be manipulated on an HTML5 canvas. Custom methods for image manipulation include loading a new image source file, zooming into an area of the image, pixelation, and glitching. An image’s glitch function is implemented using the external library glitch-canvas.46 Other methods, such as pixelation, use custom image processing defined within the `photo` component. Images can be loaded from an images folder on the server, or a Google image search can be performed to grab a random image URL from the web, based on a

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keyword. Images loaded by Google search cannot be glitched or pixelated due to the Same-Origin Policy which disallows scripting across domains for security reasons.

The video media component, *film*, adds an HTML5 video to the wall and gives the performer access to its built-in controls, such as the ability to stop or play a video, jump to a certain point in a video, loop a portion of a video, or change the speed of a video. These are simple controls; McLuhan.js is not predicated upon the idea of sophisticated video production tools or visualization tools. Instead, the goal is to use familiar communications media—in this case an HTML video player—as an instrument by being expressive with its limited controls.

A significant feature of McLuhan.js is the ability to use maps as visual material and to tell stories with them. Google maps can be loaded and explored, locations may be highlighted by map markers (pins), and text can be added above map markers to assign text to a map location. Methods on the map media component include *goto* (go to a location by name), *route* (get directions from one location to another), *stray* (move the map left, right, up, or down), and *zoom*.

In addition to loading maps, McLuhan.js has the ability to embed webpages. The *hack* media element creates an HTML <iframe> which can embed a full external website in a McLuhan.js wall. An <iframe> can load new websites dynamically, so it is a way of browsing the web from within a static and controllable page. The hack element can also scroll through the embedded webpage. While some popular websites, such as the New York Times or Facebook, do not allow themselves to be embedded via an iframe, a vast majority of websites do allow this, and an <iframe> is the most well-supported method for embedding other webpages.
Audio Media

McLuhan.js offers control of audio media components. Consistent with McLuhan.js’ other media components, these specifically engage with audio via computer media tropes. The tools provided are not general composition tools as would be found in Supercollider\textsuperscript{47} or Max\textsuperscript{48}; instead, the audio tools of McLuhan.js help the user be expressive with forms of audio that are commonly experienced in the browser.

The cassette component embeds an HTML5 audio player and harnesses it as an expressive instrument. Controls are similar to the previously described film media component, which uses an HTML5 video component. Audio from these cassettes is not processed through the library’s audio processing tools (see the Audio Processing Tools section) because the MediaElementSourceNode is a permanent node and is not garbage collected within the Web Audio API, therefore creating and destroying many instances is not viable during performance.

Another option for playing audio is the dj component, which creates an invisible audio player using Tone.js. This is useful for accompanying visuals without adding a visual audio player to the window. The dj component is channeled through the library’s audio processing tools.

A common sonic element in creative approaches to the computer is the Text-to-Speech function. Originally installed on desktop computers as an accessibility feature, Text-to-Speech has been used in many artworks, and was established as an instrument by Charles Dodge in his composition Speech Songs (1974).

\textsuperscript{47} “Supercollider,” Github, accessed on May 23, 2016, \url{http://supercollider.github.io/}.

\textsuperscript{48} “Max,” Cycling ‘74, accessed on May 23, 2016, \url{http://cycling74.com/}.
uses the web-compatible Text-to-Speech library MeSpeak.js written by Norbert Landsteiner. MeSpeak is a modular wrap of the speak.js library, which is a port of the C++ text-to-speech library eSpeak to JavaScript. In MeSpeak.js, text is not rendered to speech in real-time as an audio stream, instead the audio is rendered offline into an audio buffer. This has advantages for musical performance; the speech, as an audio buffer, can be controlled in the same ways that a cassette media component can be controlled, by jumping around in the speech file or looping parts of it. Text-to-Speech audio is sent through the McLuhan.js audio processing tools.

**Text Media**

Text, as the basis for HTML and much web communication, is a core aspect of web media and computer media. While the browser includes many styles of text, McLuhan.js provides three styles which are drawn from common digital experience: plain web text, code text, and text messages. The *paper* media component adds plain text to a wall. This text can be added in several modes: large, in the center of the wall; typed out in small text; flashing; or spread throughout the wall with one word per window. A *log* media component imitates a terminal or code console by printing individual lines of text in Courier font. This can be used for printing code text or code poetry. The *log* component intends to treat code as familiar web content to collage. Finally, an *SMS* media component visually recreates an iPhone text message. This lets a performer create fake text message conversations in the browser.

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Presence

The goal of McLuhan.js is to be a performance platform, a net art platform which is distinct in its liveness. The presence of the performer should be felt through the internet. If the browser is the stage, there should be room for the performer on the stage. With that goal in mind, the presence media component is shows the face of the performer in a pixelated form. Rather than a full video feed, a much smaller amount of data is sent in the form of a string of integers noting darkness levels for a grid of pixels. That pixel data is drawn onto a canvas as rectangles in the audience's main browser window. Overlaid on top of the pixelated video is a visualization of the text being live coded by the performer.

This imagery can always be shown in the center of the performance. While part or all of the presence may be covered by new windows and new content during the performance, the presence is what remains when all other content ends, in the same way a performer is what is left noticeable on stage after a live music performance is over.

Audio Processing Tools

McLuhan.js is not a digital audio workstation, but it does include audio processing tools to augment audio media such as the dj, film, and text-to-speech media components. Audio processing effects are controllable during performance, including a bandpass filter, a delay effect, a reverb, and an amplitude gain control. While these are established signal processing techniques that don’t specifically relate to the web, they fit the overall goals of McLuhan.js by encouraging flexible approaches to web media. For example, applying feedback delay to a text-to-speech
voice is a way of taking familiar audio media and making it flexible compositional material.

Audio effects within the wall architecture must be handled carefully. A wall may consist of eight or more browser windows, and loading eight instances of each audio effect will slow performance. Instead, it is more practical to host all audio effects within the master window, which is always open and contains the presence and the performance manager. If hosted in the master window, each audio effect is loaded only once, at the beginning of the piece, and exists continuously throughout. The audio streams from dj and voice media are connected to the audio effects chain in the master browser window. This gives the master window a consistent control over the media components that are connected to it, and each audio effect is able to keep its state as walls are created and destroyed.

Summary

McLuhan.js’ client-side tools offer the ability to manage multiple browser windows as well as a variety of media components which each engage with a different aspect of the web. These media components, and control over them, are the majority of McLuhan.js, which acts as a tool for being expressive and performative with web media. While control over each medium is simple—often offering automated control of previously human-controllable interface actions—the goal is to use this ability for automation to explore these media and reveal something unexpected and new.
**Interface**

The interface for performing with McLuhan.js is a live coding environment. Live code is used to create new events which can repeat rhythmically. The code for these events is stored in an event list, a list of text fragments which can be edited or deleted. The live coding language uses JavaScript as its base, but is designed to shortcuts and uses key commands to allow for quicker response in performance. The goals for the McLuhan.js interface are to be spontaneous, flexible, and algorithmic.

Live coding was chosen as an interface in order to send complex instructions with little network traffic. Thomas Dolby, an early experimenter with networked audio in the 1990s, joked that you cannot send a cake through a phone line but you *can* send a recipe for a cake through a phone line and make it on the other end.\(^{50}\) Live coding is an example of taking advantage of Dolby’s sentiments. Rather than sending continuous musical gestures or audio data through the web, code can contain small messages for algorithms which can cause a lot of activity in the audience’s machines.

**Environment**

The live coding environment is a small command line interface in a web browser window (Figure 19). Code is typed in one line at the bottom of the window. When executed, by pressing the Enter key, the typed line of code is added to an event list of active code fragments, described below.

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The choice to use this command line paradigm—in which a single line of code is written and executed, similar to DOS, a Macintosh Terminal, or a debugging console—was inspired by Kyle Stetz’s web audio live coding language Lissajous, in which code is written in a browser’s JavaScript console. The format is appealing; the use of short lowercase fragments of text allows the performer to rapidly start creating, and to change directions quickly without needing to write a lot of setup code. In other words, every short bit of code is an action that causes a result.

The drawback of this paradigm is that the interface is not conducive to writing long, multi-line JavaScript statements. The interface is oriented towards the collection of functions that McLuhan.js makes available. Therefore, the interface steers the user to create certain types of content. This is an acceptable concession for McLuhan.js, which aims to encourage a specific set of internet art actions. The gain in speed with a Lissajous-style interface outweighs the loss of flexibility.

Figure 19: The McLuhan.js live coding interface.
**Event List**

The *event list* creates a small interactive visualization of code fragments that have been recently executed. In this event list, fragments of code can be edited or removed. If a fragment contains rhythmic information, removing that fragment from the event list will cause the rhythm to stop happening. If a code fragment contains a function that created a media element, removing that fragment from the event list will cause the media element to be removed from the performance. Using this paradigm for live coding has advantages: it keeps the screen clear of old text and focuses the performer on the events that are presently active.

The event list format was also inspired by Ted Coffey’s *Autopoetics IV* for laptop ensemble, in which small fragments of sound are placed in collectively-editable playlists. Experiments were done to make the McLuhan.js event list a playlist, in which items could be rearranged and a “beat” moved from one item to the next in a loop. This technique was abandoned because it was too inflexible; for example, it was cumbersome to create two actions at once, or to create two events that happen in a 2:3 beat. However the idea of an event list of active rhythms evolved out of these experiments.

**Syntax**

The syntax for McLuhan.js aims to use short, lowercase words, and to accomplish a lot with a little text. All methods are in a single-page API “cheatsheet” for easy reference.51

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Creating Walls

As described previously, a wall is the basic canvas of McLuhan.js and creating a wall is the first step of any performance. Rather than making a performer create a variable to instance a new wall, the performer uses the wall method (Figure 20).

<table>
<thead>
<tr>
<th>Standard JS</th>
<th>McLuhan.js Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>a = new Wall(&quot;line&quot;)</code></td>
<td><code>wall(&quot;line&quot;)</code></td>
</tr>
</tbody>
</table>

Figure 20: Creating a wall in McLuhan.js.

After a wall is created, that wall becomes an applied context for the next lines of code. In a common JavaScript-based live coding language, like Gibber or Lissajous, creating a wall and calling the xray method on that wall would involve creating a variable `a` and calling a method on that variable. In McLuhan.js, that variable is created in the background and implied (Figure 21).

<table>
<thead>
<tr>
<th>Standard JS</th>
<th>McLuhan.js Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>a = new Wall(&quot;line&quot;)</code></td>
<td><code>wall(&quot;line&quot;)</code></td>
</tr>
<tr>
<td><code>a.xray()</code></td>
<td><code>xray()</code></td>
</tr>
</tbody>
</table>

Figure 21: A wall as an implied context in McLuhan.js.

At any time, a user can change which wall is the implied context by using a key command: ` also known as backtick or grave accent. Walls are color-coded within the typing area to show the performer which wall is currently used as the context. This is sustainable in performance because usually a performer will not
have more than two or three walls open at once, and will often be working in just one wall. Therefore, it is verbose to type “a.” at the beginning of each statement.

Creating Media

Like walls, media are not created using the “new” keyword, which is verbose during live performance. Instead, media are created via a wall’s methods. For example, a wall has a see method which creates a photo (image) component (Figure 22). Normally, a method is called on an object, as in a.see(). Here, the wall is an applied context, so the a is unnecessary.

<table>
<thead>
<tr>
<th>Standard JS</th>
<th>McLuhan.js Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>b = new Photo(“mcluhan.jpg”)</td>
<td>see(“mcluhan”)</td>
</tr>
</tbody>
</table>

Figure 22: Creating media using a shorthand method in McLuhan.js.

In addition, new media items do not need to be given their own variable name upon creation. New media are auto-assigned an ID number based on their location in the event list. The event list shows a line number, followed by a tilde, and then the code that is executed (Figure 23).

![Figure 23: Format of one line in the McLuhan.js event list.](image)
When a new media component is created, it can be referred to by its line number in the event list (Figure 24). *(Note: In this example, “1 ~ ” and “2 ~ ” are not typed. They demonstrate the resulting appearance of the code in the event list.)*

<table>
<thead>
<tr>
<th>Standard JS</th>
<th>McLuhan.js Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ~ b = new Photo(&quot;mcluhan.png&quot;)</td>
<td>1 ~ see(&quot;mcluhan&quot;)</td>
</tr>
<tr>
<td>2 ~ b.glitch()</td>
<td>2 ~ l.glitch()</td>
</tr>
</tbody>
</table>

Figure 24: Using a line number as a reference in McLuhan.js. In the example on the right, the “1” in line 2 invokes the image created in line 1.

This syntax is aimed at achieving speed in performance. The auto-assignment of variable names means a performer does not need to remember what letter to use before creating a new media component.

Thor Magnusson’s Threnoscope language uses ID auto-assignment as well. Threnoscope auto-assigns three-letter variable names for new sounds that are created.\textsuperscript{52} Generally this makes it easier for the performer to create simple, direct actions in the present moment while minimizing the larger-scale organizational forethought that is usually involved in live coding.

**Chaining Functions**

All media functions in the McLuhan.js API can be chained together, because all functions return their media component (Figure 25).

Rhythms

During development of the McLuhan.js interface, it quickly became apparent that each line of code needed to cause more than one action. Each code fragment needed to initiate a process that was ongoing, so that audiovisual events could layer and interrelate. To do this, a rhythm constructor called `VariableSpeedInterval` was created. This constructor creates a controllable rhythmic interval using JavaScript’s native `requestAnimationFrame` function. In the McLuhan.js environment, an interval is created by adding `@ N` to the end of a line of code, meaning that line of code will happen every N milliseconds (Figure 26). A performer can change the interval duration at any point by directly editing the text in the event list and hitting enter.

<table>
<thead>
<tr>
<th>Standard JS</th>
<th>McLuhan.js Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>1 ~ c = new Cassette(&quot;piano&quot;)</code></td>
<td><code>1 ~ hear(&quot;piano&quot;).jump(10)</code></td>
</tr>
<tr>
<td><code>2 ~ c.jump(10)</code></td>
<td></td>
</tr>
</tbody>
</table>

Figure 25: Chaining two functions in McLuhan.js.

<table>
<thead>
<tr>
<th>Standard JS</th>
<th>McLuhan.js Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>1 ~ a = new Cassette(&quot;phone.mp3&quot;)</code></td>
<td><code>1 ~ hear(&quot;phone&quot;)</code></td>
</tr>
<tr>
<td><code>2 ~ setInterval(&quot;a.jump(10)&quot;, 300)</code></td>
<td><code>2 ~ 1 jump(10) @ 300</code></td>
</tr>
</tbody>
</table>

Figure 26: Creating a repeating interval in McLuhan.js.

There are many unexplored opportunities for creating expressive timing features, such as rhythms that change linearly over time, random rhythms, or patterned rhythms. Rather than existing within McLuhan.js, that type of project
should be its own standalone JavaScript library for general use and then integrated into McLuhan.js.

Loops

A vital shorthand is the loop shorthand to make code iterate several times, written `-l 10` for a loop of 10 (Figure 27). This short mark is in stark contrast to standard JavaScript, in which a loop would require much more text, a verbosity McLuhan.js tries to avoid. The following code creates 10 cassette media components. The first will loop a region of 0'00 to 0'01, the second will loop a region of 0'01 to 0'02, and so on.

**Standard JS**

```javascript
1 ~ piano = []
2 ~ for (var i=0;i<10;i++) {
   piano[i] = new Cassette("pno.mp3")
   piano[i].skip(i, i+1)
}
```

**McLuhan.js Environment**

```javascript
1 ~ piano = []
2 ~ -l 10 piano[i] = hear("pno").skip( i, i+1 )
```

Figure 27: A shorthand for iterative loops in McLuhan.js.

**Helper Functions**

As is customary to most live coding languages, McLuhan.js has a small collection of shorthand helper functions for common music tasks. These functions are global, invoked short names such as `r()` for a random integer or `mtof()` for a midi-
to-frequency conversion. Other functions in the toolkit include *bounce* (also inspired by Lissajous) in which the output “bounces” back and forth between two numeric boundaries, and *invert* which maps an 0-1 input to 1-0 output. In the example below, the random float function *rf()* seeks an audio file to a random location every 300 milliseconds (Figure 28). These functions re-evaluate each time they are called, so that *rf(5)* outputs a new random float between 0 and 5 each time the rhythm repeats, rather than outputting the same random float every time.

<table>
<thead>
<tr>
<th>Standard JS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ~ a = new Cassette(“phone.mp3”)</td>
</tr>
<tr>
<td>2 ~ setInterval(“a.jump(Math.random()*5)”, 300)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>McLuhan.js Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ~ hear(&quot;phone&quot;)</td>
</tr>
<tr>
<td>2 ~ 1 jump(rf(5)) @ 300</td>
</tr>
</tbody>
</table>

Figure 28: A shorthand for creating random float numbers in McLuhan.js

McLuhan.js uses live coding as an efficient way to send complex information through the network. Through a collection of shorthands within the environment, live JavaScript coding is adapted to be the a flexible and lightweight method for controlling a McLuhan.js performance.
**Server-Side**

McLuhan.js is a distributed internet art performance platform in which performance commands are sent through the internet to create net art actions in the browsers of remote viewers. This requires a custom server to manage the distribution of commands from the McLuhan.js interface. This server is built with Node.js and relies heavily on Node’s Socket.IO websocket package, while also making use of Parse Database to store data mid-performance. The server provides tools for transmitting live code messages, handling dropped messages, and handling users who connect mid-performance.

**Architecture**

The server is written in Node.js, a platform for running JavaScript outside of the web browser. The Node package Socket.IO is used to create websockets which open real-time communication between performer, server, and audience. The Node package Express is used to serve webpages by HTTP. The server opens a new socket for each user. Within each socket, several event listeners are created for actions like transmitting live code messages and the presence video feed. The server keeps track of how many audience members are connected, and how many have disconnected during a performance.

Socket.IO event messages are sent with two arguments: *type* and *data*. Rather than open an event listener for each type of data, one general event listener

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is created for all performance messages. The type argument is a string denoting what type of data is being sent (such as “entry” for a new live code entry). The data argument is a JavaScript object containing the data to be sent (such as the text of a new live code entry). As messages are received in the audience’s page, different types of data are sorted and acted on accordingly.

Performance Aids

The server is designed not just to serve websites, but to manage an art performance. To do so, its design requires tools to ensure that the audience can view the performance as smoothly as possible, even if they get temporarily disconnected or join mid-performance. During performance, certain key pieces of information are stored in a database. This information includes what walls are currently open, what shape they are in, and the list of active media components. When a user connects mid-stream, this information is referenced and walls are opened to prepare the performer to experience the next part of the performance.

Studies have shown that Socket.IO 1.0 can handle significant traffic if the server machine’s resources are adequate. Still, the server designed here is not for massive performances. Instead, it puts a hard cap at 100 audience members. If 100 audience members are connected, the server begins to redirect new connections to a waiting space, asking them to check back later or view a later performance. This is done to prevent server overloads. For the performance of The Last Cloud, the server is hosted at Heroku, a public Node.js server hosting site.

3. THE LAST CLOUD

*The Last Cloud* (2016) is an online distributed net art performance in which web browsing is engaged with as an art form. The performance uses live coding to control several browser windows with HTML media, which is collaged in a narrative mash-up. The work is accompanied by a web audio composition which uses samples, synthesis, and audio processing to put the sound of web browsing in a musical context.

The subject matter of *The Last Cloud* is a reflection on daily life and daily digital life. The piece suggests that computer desktop imagery and HTML5 audio players are as much a part of our life experience as trees and cars. The piece accomplishes this by juxtaposing common digital media with natural imagery. In one scene, a video of birds is pixelated to turn the birds into pixels. In another scene, a video of a tree is shown as a 6-second GIF loop, commenting that even our memories of nature are affected by their digital mediation. Part of the piece uses a phone dialtone as a central component of harmony, elevating the telephone's by-product to a place of musical significance. By elevating ancillary aspects of communications media in this way, they are shown as important content of our lives, rather than by-products to be ignored.

*The Last Cloud* also functions as a visual lecture, a series of moments that each point to lessons about media. Through its juxtapositions and unorthodox presentations of familiar media, the piece exposes a way of looking at the world. The audience adopts that perspective during the piece, an event which may change how they look at the world after. These lessons include that communications media
are flexible materials for creation, and that the content of 21st century life is shared between digital and physical spaces.

**Form and Material**


While the work does not follow an established formal paradigm, it does exhibit certain tendencies. There is an intentional disruption of structural rhythm; longer narrative moments contrast with moments of brevity. For example, while Part I is nine minutes long, Part II is only three minutes long. Each part is subdivided into subsections which also exhibit this lack of structural rhythm. While the first subsection of Part I is 5 minutes long, the final subsection of Part 1 is a fleeting one minute.

Filling this form is a collection of media drawn from daily life and from personal digital experience. Composing *The Last Cloud* involved odd processes such as searching for sounds that are in tune with a dialtone. Auditory artifacts of digital platforms, such as the Macintosh loading sound, were approached as a starting
point for the composition. Emotive and overtly sentimental harmonies and timbres—such as high piano notes or major chord drones—were also sought out with the goal of placing banal artifacts from digital life in an emotional context.

Moments

The score for The Last Cloud (see Appendix) can best be analyzed as a series of audiovisual moments which combine to form the parts and subsections of the composition. These moments are similar to musical phrases or periods; each moment has its own integrity based around musical material or a visual theme which lasts for the full moment. Part I has four moments: Quicktimes, This Was Life, Phone, and Skip. Part II has three moments: SMS, Silence and Noise, and Rapid Text. Part III has four moments: Dream Glitch, Mouse Wheel, Now, and Wonderland.

Quicktimes

The Last Cloud begins with two gestures which expose web communications media as a creative instrument. Four windows are rapidly opened and closed, turning empty browsers into animated visual material. The rectangular web browser window, which is usually the frame for content, becomes content on its own. This is mirrored in the next gesture, a deployment of 88 audio players, each looping one of eight different audio files (Figure 29). The black frame of the audio player, multiplied by 88 instances, takes on a visual presence. Music is made through the sum of the players and the rhythmic interaction between the different loops. Rather than playing back a finished composition through an audio player, each audio player
becomes one note in a larger composition constructed in the web page through HTML.

Figure 29: A scene from *The Last Cloud*, Part I: "Life".

**This Was Life**

Covering all four windows with a Google map, the digital content transitions to a grounding in physical life: travels across America. Through a series of videos of life, nature, and a computer desktop, the content of life during those travels is shown. A drone recording and prepared piano recording layer with the 88 piano loops to form an emotive audio accompaniment. This moment introduces the illusion of the `xray() method. Each window is scrolled according to its placement on the screen, creating the appearance of one map spread across all windows (Figure 30).
Another video—a large flock of birds taking flight—is loaded while an audio file ("birdnoise") crossfades the sound of birds into the sound of wind noise. As the wind noise fades in, the bird video is pixelated. Each bird becomes a moving black pixel creating the appearance of visual noise, akin to TV fuzz. Therefore, the visual transition to noise mirrors the audio transition to noise. Additionally, the pixellation of birds into noise reveals a relationship between natural motion and digital motion—that the randomness and patterns found in digital materials are also found in nature, and that the digital is an extension of nature. The fade out of noise concludes the first subsection of Part I.

Figure 30: A scene from *The Last Cloud*, Part I: "Life".
Phone

The second subsection of Part I engages with artifacts of telecommunications technology: phones, video chats, and app icons. First a phone dialtone is transposed down a half step and sounded, then harmonized by a recording of a bowed vibraphone. Meanwhile, the icons from an iPhone home screen are shown and each window is scrolled rapidly, reducing this familiar imagery to blurry fragments of moving color.

The latter half of this moment shows a video of a glitching Google Hangout, superimposed with a website of scrambled text. The glitching face in the Google video chat is a cross-section of the human and the digital. The digital representation is shown to add a layer of surrealism onto life. The digital error can be seen as a dream—connected to real life and drawn from real life, but rendered through processes that lose connection with reality. The stillness of the vibraphone recording and dialtone connect these two different scenes into one moment.

Skip

The dialtone sustains through the final moment of Part I. In this moment, audio players return in harmony with the dialtone. First, an E major chord is looped at 100 milliseconds by rapidly scanning a Quicktime player. The E major harmony reinforces the dialtone's E major dyad with an E major triad an octave higher. Then, a low piano note A, looping every 5 seconds, adds a dramatic uncertainty to the harmony by recontextualizing the E major chord as an A major chord with a major 7 and a sustained 9. As the low piano note sounds, fades, and sounds again, the oscillation between E major and A major harmonies closes Part I in a subtle plagal
condition. Meanwhile the four browser windows rapidly jump to random locations around the screen as the wall structure breaks down and dissipates.

**SMS**

Building off of the phone theme in Part I, Part II begins with a text message. This is a moment of humor; a text of “hey” is not expected to be projected in an art performance. The texting soon becomes rapid, turning the text ringtone into a drone which is filtered and passed through reverberation. The text used in this section is taken from a web tool by Allison Parrish which searches the Gutenberg poetry database and returns every line containing a search word. In this case, the text is of every line containing the word “dream,” “dreams,” or “dreaming.”

**Silence and Noise**

A brief moment contrasts a silent skipping audio player, accompanied by the sound of a noise generator. The silence of the audio player turns it into a purely visual element, subverting expectations.

**Rapid Text**

The same text used in the prior SMS moment is used again in a new moment, flashed across the screen in a strobe. This moment inverts the common way of experiencing text. Usually, sentences are written across space on a page. Here, sentences are written across time.

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Dream Glitch

Part III begins with 24 layered audio players and an image of Marshall McLuhan’s phrase “The Medium is the Message.” The image is recursively glitched as audio players play a distorted low drone that interferes with the browser’s audio process through its unstable signal.

Mouse Wheel

The audio players are layered with a looping video of a Macintosh “waiting” mouse wheel and scrolling source code. A handful of audio players containing E major sine tones are spread in random locations across the wall, their summed signals also distorting. The sublimity of this moment holds a feeling of endlessly waiting in the present moment. This moment seeks to convey the feeling of being inside the medium, seeing its code and its artifacts, rather than its surface. Lastly, the reference to McLuhan adds to the performance’s communication as a lecture; adding hints about the origins of the piece helps the audience view the performance more accurately.

Now

This short moment contributes a core message to the work. A Wikipedia page is loaded and scrambled, browsing the web as an artistic gesture. The moment proceeds with the digital text “now”—the subject of this composition—and then transforms them artistically through glitching and echoing. A Macintosh “on” loading sound is echoed and filtered into a major chord drone while the Wikipedia article
about “Life” is shown. The collage in total emphasizes that these digital formats and artifacts are content of life now.

Wonderland

Part III closes with a video of subway transit, boarding a train to a place labeled “Wonderland,” while a voice sample sings the traditional melody “Lowlands Away” on top of the drone of the Macintosh loading sound. The video is pixelated and the Macintosh chord drone filtered and faded until the closing of the performance.

Performance

*The Last Cloud* (Part I) was performed at the 2nd International Web Audio Conference on April 4th, 2016 at Georgia Tech University in Atlanta. *The Last Cloud* was additionally performed in its entirety at Louisiana State University on May 2, 2016. In the latter performance, audience members viewed the performance in-person in a live audience and from remote locations.
REFERENCES


“Interview with Jud Yalkut.” Arts Magazine. April, 1968.


**APPENDIX: LIVE CODE SCORE FOR THE LAST CLOUD**

*The Last Cloud* (2016) by Benjamin Taylor

Performance Instructions:


2) Interpret the score below in the following way. At the time given (in the left column), type and execute the code command given (in the right column).

3) The [x] symbol indicates to remove that line of code by clicking on its closing [x] button in the performance interface.

4) McLuhan.js uses auto-created references for media items, based on the line number of that media item in the live coding interface. Since the performer might type extra lines of code either by accident or as improvisatory gestures, the line numbers written in this score may differ from the line numbers of any given performance. Therefore, line numbers have been omitted in this score and replaced with a unique media index. As each media item is created in this score, it is given a unique index, starting at 1, in the score (see for example the 7th line: 2 ~ explore("america") ). This index is used later in the score to refer to that media item, however in performance it should be replaced by the line number of the media item. Therefore if the line number of the command explore("america") in the live coding interface is 7, then the 10th line of the score should be written as 7 route("youth") rather than 2 route("youth").

5) This performance relies on a large amount of audiovisual media prepared by the composer. That media can be found at <http://www.github.com/taylorbf/the-last-cloud>
Part I: “Life”

Type and cut to clipboard:
-1 22 piano[i] = hear("piano"+r(8)).move(0,i*30).jump(i%15)

0’00” ~ wall("big4")
0’10” ~ show() || hide() @ 300
0’20” ~ shape("line")
0’30” ~ shape("frame")
0’40” ~ shape("line")
0’45” ~ piano = []

[x] show() || hide() @ 300
0’55” ~ show()
1’00” ~ Paste from clipboard:
-1 22 piano[i] = hear("piano"+r(8)).move(0,i*30).jump(i%15)
1’20” 1 ~ dj("displacement")
1’30” 2 ~ explore("america")
1’45” ~ xray()
1’55” 3 ~ dj("reflected")
2’10” ~ 2 route("youth")
2’20” 4 ~ write("I lived across America")
2’35” 5 ~ watch("walk")

[x] this was life
2’45” 6 ~ write("this was life")
3’00” ~ 5 load("tree")
3’20” ~ 5 load("ride")
3’40” ~ 5 load("sunset")
4’00” ~ 5 load("mouse")
4’05” ~ scatter()
4’15” ~ -1 22 piano[i].kill()
4’20” ~ shape("line")
4’30” 7 ~ watch("birds")
4’40” 8 ~ dj("birdnoise")

[x] watch("walk")
[x] dj("reflected")
5’00” ~ 7 pixelate(20)

[x] dj("displacement")
5’10” ~ phone.transpose(-1)
5’20” ~ empty()
5’30” ~ phone.dialtone.start()
5’40” 9 ~ see("ios")
5’45” 10 ~ dj("vibes")
5’55” ~ scramble() @ 50
6’30” 11 ~ watch("skype")

[x] see("ios")
[x] scramble() @ 50
6’40” ~ xray()
7’00” 12 ~ hack("whitechord.org/dreams").fade(0.3)
7’20” ~ empty()
7'45" 13 ~ hear("Emaj").skip(1,1).move(300,50)
8'00" 14 ~ hear("piano0").skip(0,5).move(300,100).vol(1)
8'10" 15 ~ size(150,150)
8'20" 15 ~ watch("ride").pixelate(100)
8'30" 15 ~ scatter() @ 100
9'00" 15 ~ phone.dialtone.stop() && kill()

Part 2: “Dreams”

0'00" 1 ~ wall("r8")
0'05" 1 ~ text("hey")
0'10" 2 ~ dj("ringtone")
0'20" 3 ~ 1 scroll() && 2 skip(1,1.1)
0'30" 3 ~ 1 read("dreampoem")
0'40" 3 ~ hall.wet(0.9,30)
0'50" 3 ~ hall.size(0.97,20)
1'30" 3 ~ empty() && hear("silence").move(25,25)
1'40" 3 ~ noise.vol(0.5)
1'45" 3 ~ noise.start()
2'20" 4 ~ write("dreampoem").flash()
2'30" 4 ~ 4 flash() && noise.vol(0.7,0,0.05) @ 100
3'30" 4 ~ kill() && noise.stop()

Part 3: “Wonderland”

0'00" 1 ~ wall("grid16")
0'05" 1 ~ hear("dreamdrone")
0'15" 1 ~ hall.wet(0.4,20)
0'30" 2 ~ hear("scratch").move(0,100)
1'00" 3 ~ hear("gnarly").move(0,200)
1'10" 4 ~ see("mcluhan")
1'20" 4 ~ 4 glitch() @ 200
1'30" 4 ~ 4 fade(0.8)
1'40" 4 ~ 4 load("mcluhan")
1'50" 4 ~ 4 load("mcluhan")

[x] hear("scratch")
[x] 4 glitch() @ 200
[x] see("mcluhan")

2'15" 5 ~ watch("wheel")
2'20" 5 ~ 5 fade(0.8)
2'45" 6 ~ -1 2 hear("Emaj").skip(0,5).move(r(800),r(500))
2'55" 6 ~ log().load("client.html")
3'30" 7 ~ -1 3 hear("Emaj").skip(0,5).move(r(800),r(500))
3'55" 7 ~ xray()
3'45" 7 ~ -1 2 hear("Emaj").skip(0,5).move(r(800),r(500))

4'30" 7 ~ empty() && wiki("art")
4'45" 7 ~ load("life")
4'55" 7 ~ scramble()
5'05" 7 ~ xray()
5'15" 8 ~ see("now").fade(0.6)
5'25" 8 ~ dj("boot")
5'40" 8 ~ hall.wet(0.4,10)
5'50" 8 ~ hall.size(0.7,10)
6'00” 10 ~ dj("boot")
6'15” 11 ~ watch("wonder1").fade(0.7)
6'30” 12 ~ dj("lowlands")
6'45” ~ 11 load("wonder2")
6'55” ~ 11 speed(0.25)
7'00” ~ 11 pixelate(100)
7'25” ~ 11 load("wonder3")
7'30” ~ 11 speed(1)
7'35” ~ 11 pixelated = false

After second song repetition:
[x] dj("lowlands")

8'00” ~ echo.fb(0.7,30)
8'10” ~ bp.q(3,60)
8'20” ~ bp.freq(5000,45)
8'50” ~ 11 pixelate(100)
9'00” ~ vol.to(0,20)
9'20” ~ kill()
Ben Taylor is an interdisciplinary artist and creative coder who specializes in net art, web audio, and networked performance practices. His research investigates the way ideas translate between the arts, and how we can apply that history to guide the artistic use of networks. He likes to build toolkits that help other people make art with the internet.

Ben has presented his research internationally at conferences and festivals including the Pixilerations New Media Festival (Brown/RISD, 2011), New Interfaces for Musical Expression (NIME 2013 Seoul, 2014 London), Web Audio Conference (IRCAM/Mozilla 2015), Leaders in Software and Art, International Computer Music Conference (ICMC 2015), Music for People and Thingamajigs, and others. He is a founding member of the Louisiana Mobile App Orchestra (LMAO), and his music has been released by the Society for Electroacoustic Music in the United States (SEAMUS).

He received an M.F.A. In Electronic Music & Recording Media from Mills College and has studied with members of the League of Automatic Music Composers and The Hub, Brian Harnetty, and Pauline Oliveros.

When not making art with the web, Ben is a developer and CTO at bitdreams.io, a creative audio app company, and teaches creative coding at Goucher College Digital Arts.