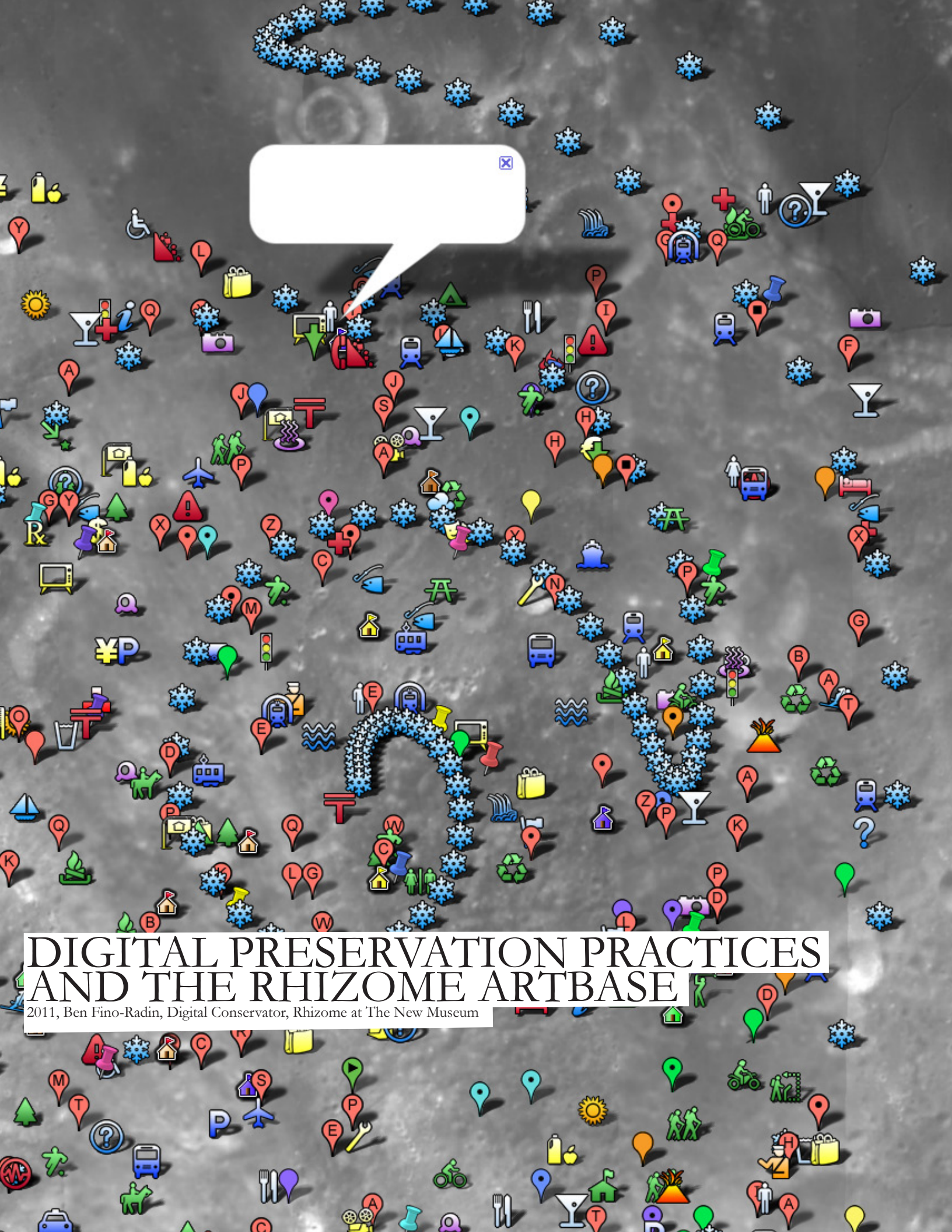

DIGITAL PRESERVATION PRACTICES AND THE RHIZOME ARTBASE

2011, Ben Fino-Radin, Digital Conservator, Rhizome at The New Museum

"The computer language, operating system, and hardware form an infrastructure that supports the artwork, but they are not the artwork. The artwork is an algorithm, a design built on this infrastructure, which is constantly changing and rapidly aging. To hold onto that technology is to tie us to a sinking ship. We have to be nimble enough to jump to the next boat, and our artwork has to be adaptable enough to do that gracefully."
Mark Napier in conversation with Jon Ippolito, at "Preserving the Immaterial: A Conference on Variable Media," Solomon R. Guggenheim Museum, New York, 2001.
(Depocas, 2003)

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ABSTRACT

This paper aims to provide an analysis of the past and present digital preservation practices of the Rhizome ArtBase, and to extract from this a sustainable framework for the future that bears in consideration the fluidity of the field.

MISSION STATEMENT

Rhizome is a non-profit organization dedicated to the creation, presentation, preservation, and critique of emerging artistic practices that engage technology. Through open platforms for exchange and collaboration, our website serves to encourage and expand the communities around these practices. Our programs, many of which happen online, include commissions, exhibitions, events, discussion, archives and portfolios. We support artists working at the furthest reaches of technological experimentation as well as those responding to the broader aesthetic and political implications of new tools and media. Our organizational voice draws attention to artists, their work, their perspectives and the complex interrelationships between technology, art and culture. Rhizome played an integral role in the history, definition and growth of art engaged with the Internet and networked technologies; first as an email list founded in 1996, and fifteen years later, as thriving nonprofit.

The Rhizome ArtBase, established in 1999, is an online archive of new media art. Its scope encompasses a vast range of projects by artists all over the world that employ materials such as software, code, websites, moving images, games and browsers to aesthetic and critical ends.

ARTBASE HISTORY

The preservation of digital content is no new topic. From the Library of Congress, to the United Kingdom's National Archives, to digital asset management in the private sector, there are stakeholders large and small that have for many years worked to ensure the longevity of digital content. There are some who warn of a digital dark age (Kuny, 1997), and others who ask for any tangible examples of truly dead digital formats (Rosenthal, 2010). Parallel to this emergent discourse and establishment of best practices has been the evolution of preserving artwork that employs technology or exists digitally. Human questions of an artist's intent, material, conceptual authenticity, and commodification compound the existing complexity over longevity and data authenticity that any conservator of digital material must consider.

Since the early to mid 1990s, collecting institutions have spawned new preservation practices, restorative strategies, and institutional collaboration. Nevertheless, a hard set of established best practices has yet to emerge. This is due in part to the comparative infancy of the field, but also that we are faced with the unique dilemma that our tools, practices, and the art objects we seek to preserve are in a perpetual state of flux. Considering the last fifteen years of publications in the field; theoretical models and practical strategies become obsolete with rapidity, as they are inextricably linked to a rapidly evolving infrastructure. This paper will provide a specific and thorough overview of the past and present efforts of the Rhizome ArtBase.

Its purpose is both to serve as a document of a moment in the ArtBase's evolution, and to provide a more general framework and perspective of digital preservation.

As laid out in its mission statement, Rhizome supports "artists working at the furthest reaches of technological experimentation." Works of this nature are inherently fragile. The interconnected nature of technology creates a tenuous situation wherein the actions of external parties (developers, corporate bodies) directly affect the ability to access and experience an artwork. The mission of the ArtBase is two-fold: provide free, open access to a public collection of new media art objects, and preserve these works in a sustainable archival format. The ArtBase aims to preserve art objects as close as possible to their original context, and to offer the sustained ability to research and interact with these works and the history that they as a collection communicate.

Many works in the collection are entirely born-digital and without physical counterpart, thus it follows that the ArtBase aims not simply to catalog, index, and preserve, but primarily to promote and ensure access to these transmissible art objects. The last decade saw a great period of growth in the ArtBase, and the preservation field at large. What began as a web platform for presenting and sharing art work, grew into an effort more conscious of preservation and bibliographic practices.

In 2002, Richard Rinehart, then Berkeley Art Musuem's Digital Media Director, and Adjunct Curator) wrote "Preserving the Rhizome ArtBase." This paper laid the initial foundation for the ArtBase's preservation standards. This paper provided suggestions for moving the ArtBase's practices towards a sustainable preservation model. Rinehart provided a hypothetical ArtBase meta-data schema[1], the implementation of an ArtBase questionnaire[2], the suggestion of a tool for collecting metadata, and emulation as a preservation strategy. A decade later, many of Rinehart's broader suggestions remain relevant. Due to various infrastructure limitations of budget and staff, many remain to be implemented.

In 2003, Variable Media Network[3] published: The Variable Media Approach: Permanence Through Change. This report provided institutional perspectives of the five entities that comprised the VMN[4] , the preservation practices that the consortium agreed upon, six case study analyses of restoring historic works of variable media, as well as excerpts from the 2001 conference "Preserving The Immaterial: A Conference on Variable Media." These case studies revolved around issues of ephemerality, authenticity, and reinterpretation. Jeff Rothenberg, a computer scientist and researcher, contributed a case study providing documentation and analysis of the preservation and re-exhibition of Grahame Weinbren and Roberta Friedman's early interactive piece The Erl King. This study provided a detailed account of the challenges in mitigating technological obsolescence. In 2006, Rothenberg produced his paper "Renewing The Erl King," which expanded this case study into an in-depth, technologically explicit account. To date, Rothernberg's 2006 study is arguably one of the most in-depth analyses of practicing emulation of a digital art object.

In 2008, Ward Smith, a graduate student at the Getty Institute, authored two papers that surveyed the ArtBase's practices, and offered a path to a more flexible, interoperable, and authoritative database model. Among Smith's suggestions were some so basically essential as the implementation of controlled vocabularies[5]. This is illustrative of some of the major steps taken over the course of the last few years. An effort lead by Rhizome's Director of Technology Nick Hasty along with David Nolen, and Mushon Zer-Aviv, elevated the ArtBase's management system from a basic web model to an authoritative records system. This transition allowed Rhizome

1 With crosswalk to Dublin Core, CDWA, MARC, and EAD

2 A variant of the Variable Media Questionnaire (VMQ) developed in conjunction with the Guggenheim and the Variable Media Network. The original VMQ was created in order to afford conservators a means to extract and document an artist's intent and wishes regarding the preservation, restoration, and future exhibition of a specific artwork.

3 A consortium founded for the purpose of facilitating resource sharing, communication and collaboration between arts institutions who found themselves to be stakeholders in the longevity of electronic, digital, and computer-based art forms that had begun to enter their collections.

4 Berkeley Art Museum/Pacific Film Archive, Franklin Furnace Archives, Inc., Performance Art Festival+Archives, Rhizome, and Walker Art Center.

5 Such as the Art and Architecture Thesaurus, Union List of Artist Names, and the Getty Thesaurus of Geographic Names

to initiate contributions and collaborations with institutional collections such as the Getty and ArtStor. This evolution was years in the making and currently exists in beta, remaining under constant development.

Despite this massive refinement of the ArtBase's records system, preservation concerns still need to be addressed. This is partially strategic, with the understanding that the depth and scope of preserving the works contained in the ArtBase would be a futile attempt without a refined records system. As such, preservation policy and procedures have yet to be established and tested in practical situations. It is the goal of this paper to outline proper policy and procedure for preservation in the ArtBase, as well as contribute to the ongoing dialog of emergent best practices in preserving digital artifacts.

This will be presented in six parts: First, the three inherent vices of new media are presented: diffusivity, data obsolescence, and physical degradation. These are provided within the context of four art objects[6], as a foundation for understanding and forming the archival process, and potential restorative strategies. Secondly, the requisite initial steps of acquiring a new work are provided. This includes the development of a more dynamic and usable model of the Variable Media Questionnaire. Third, the works presented in the first section will be revisited to provide specific examples of the range of materials that must compose a work's archival package in order to mitigate the inherent vices specific to the object. Fourth, the art objects used previously as examples demonstrating inherent vice, and archival processes are revisited in the context of potential restorative strategies. Fifth, the ArtBase's bibliographic model will be explored. This details the ArtBase's schema and vocabularies, how these are interoperable with current standards, and how Rhizome will be contributing this data to other institutions. Sixth, in conclusion, recommended next steps and future preservation initiatives, and special projects for the ArtBase will be offered.

PRIMARY RISKS & INHERENT VICE

There are three essential threats to the preservation and permanent access to works of new media: diffusivity, data obsolescence, and physical degradation. This section will explore these risks as they apply to specific art objects. These works are provided as a basis for approaching solutions that may mitigate these risks. Each inherent vice manifests itself in a variety of forms – thus more than one art object will be used to illustrate each vice. Additionally, these challenges are not mutually exclusive, and an art object may be susceptible to a combination of the three. Here however, we will only explore one inherent vice respective to the presented art objects, for sake of clarity.

Diffusivity is a term that refers to works whose data is not contained within one simple object, works that reference external databases, or dynamic and real-time data sources. Diffusivity also refers to works that do

6 A term that will be used throughout the paper to refer to works of art that are composed of physical, digital, or variable media.

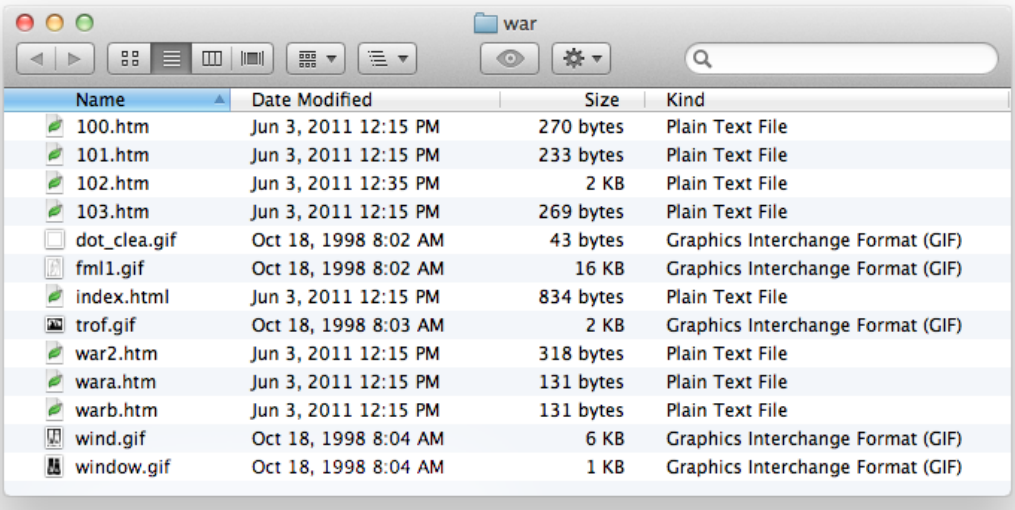

Fig.1 The entireity of *My Boyfriend Came Home From The War* – one directory, all static files, totaling 70kb

not exist solely in one location, but as a series of actions over a variety of locations and platforms (Moss, 2009). Historically speaking, there are plenty examples of Internet based works that are self contained such as a domain name that points to a single page website. Yet, other works present a structural complexity that creates new problems for the archive. An early example of a simple, packageable, or self-contained work is Olia Lialina's My Boyfriend Came Home from the War (1996). The piece consisting entirely of HTML, CSS, and image resources contained within a directory structure (Fig. 1), is easily duplicated and migrated to the ArtBase. A more contemporary example is the work of Rafaël Rozendaal, whose art objects each occupy a unique domain name, and generally consist of embedded flash animations.

A work that is diffuse presents a data structure that is diametrically opposed to singular authority and ownership. Legendary Account by artist Joel Holmberg for instance, exists as a series of actions within the Yahoo! Answers service. Holmberg's piece *"…involves the artist asking profound, existential questions in the user-generated forum Yahoo! Answers, which requires users to select categories like "Pets" or "Home Maintenance" before posting. It is commonly used for questions like "Where is the nearest pet store?" Holmberg's questions—including "How does it feel to be in love?" or "How do I best convince someone I am an artist?" or "How do I occupy space?"—subvert the simple Q&A service. They are too searching, too complex; they tease the system of Yahoo! Answers and challenge commenters to interpret and grapple with philosophical questions."* (Free, 2010) The fact that this project exists within

the Yahoo! Answers service is problematic for the archive; the work is difficult to define as a singular art object outside of its natural habitat. Currently, the artist hosts documentation of the piece on his website as .jpg screen-shots. To what extent this suffices is subjective to ones definition of authenticity and experience. While there are strategies for scraping the data and interface of these Yahoo! Answers pages and reproducing them as static HTML/CSS/Javascript, they would remain a simulation of the original work, a limited representation or reproduction, that does not reproduce the context in which Holmberg's questions would be typically encountered. This piece typifies the extent to which diffusive works challenge traditional notions of authenticity, such that any preserved iteration is rendered no more than a document.

Next, we will explore the inherent vice of data obsolescence as illustrated by two works: globalmove.us[7] by artist collective JODI[8], and Floccus by Golan Levin. Globalmove.us is a glitch website that implements HTML, Javascript, and the Google Maps API[9] . Through the combination of the API and home-brew Javascript, the artists have created a website that negates user interaction, and creates frenetic, drawings using Google Maps interface elements (see cover image). Here, the Javascript that interacts with the Google Maps API is essentially the functional part of the piece – it is what causes the embedded Google Map to rapidly place UI elements and create drawings. This Javascript, just as any other form of code or software, is reliant on a specific infrastructure. In this case, this infrastructure is the API. Google's Map API undergoes constant development just as any other software, and as such features, functions, and methods go through cycles of deprecation and eventual obsolescence. This inevitably affects how developers' and artists' code interact with it. Sooner or later, JODI's Javascript will be rendered ineffective, thus eliminating the work's sole functional element.

Data obsolescence is perhaps the most pervasive threat to digital works. It is inherent in all forms of digital and variable media. New media at its very core is built, and manifested on tools and technology that are interdependent – no element of new media is autonomous. There is no artist or programmer who is not dependent on (or limited by) infrastructure built by other programmers, and for better or for worse the legacy of these structures. An artist who writes custom software, relies on running within a specific operating system, and therefore on specific hardware. A current such case is illustrated by Golan Levin's piece Floccus[10]. This art object, originally created in 1999, has to date witnessed two generations of obsolescence. Levin originally created the piece using the C++ programming language and OpenGL (Open Graphics Library). It was then compiled as an applet capable of running either as a "stand alone" piece of software, or as an element embedded in a web page.

7 http://globalmove.us/

8 composed of net artists Joan Heemskerk and Dirk Paesmans

9 http://code.google.com/apis/maps/index.html

10 http://www.flong.com/storage/experience/floccus/

In the intervening seven years after its creation in 1999, computer systems evolved and support for the applet began to disappear. In 2006, the artist found that the applet began to fail, and would no longer run on many contemporary systems. Levin remedied this by recreating the piece using Processing[11], a tool that emerged since the works initial creation. This process also rendered an applet, which Levin embedded on a page of his website.

Floccus was again rendered obsolete; until recently the web-based applet would not run, and visitors to Levin's site or the ArtBase would be presented with only a blank white box and error message. After investigating the issue, Levin found the problem to be that the applet was compiled to run on now obsolete 32 bit systems. Today, 64 bit systems are the predominant norm, and prior to it's repair, the applet was likely unusable for the majority of visitors to his website. This particular case is a perfect example of the recurrent nature of obsolescence; once an obsolete art object is restored, it is only a matter of time before the solution is rendered obsolete. The most evident repercussion is the work of art no

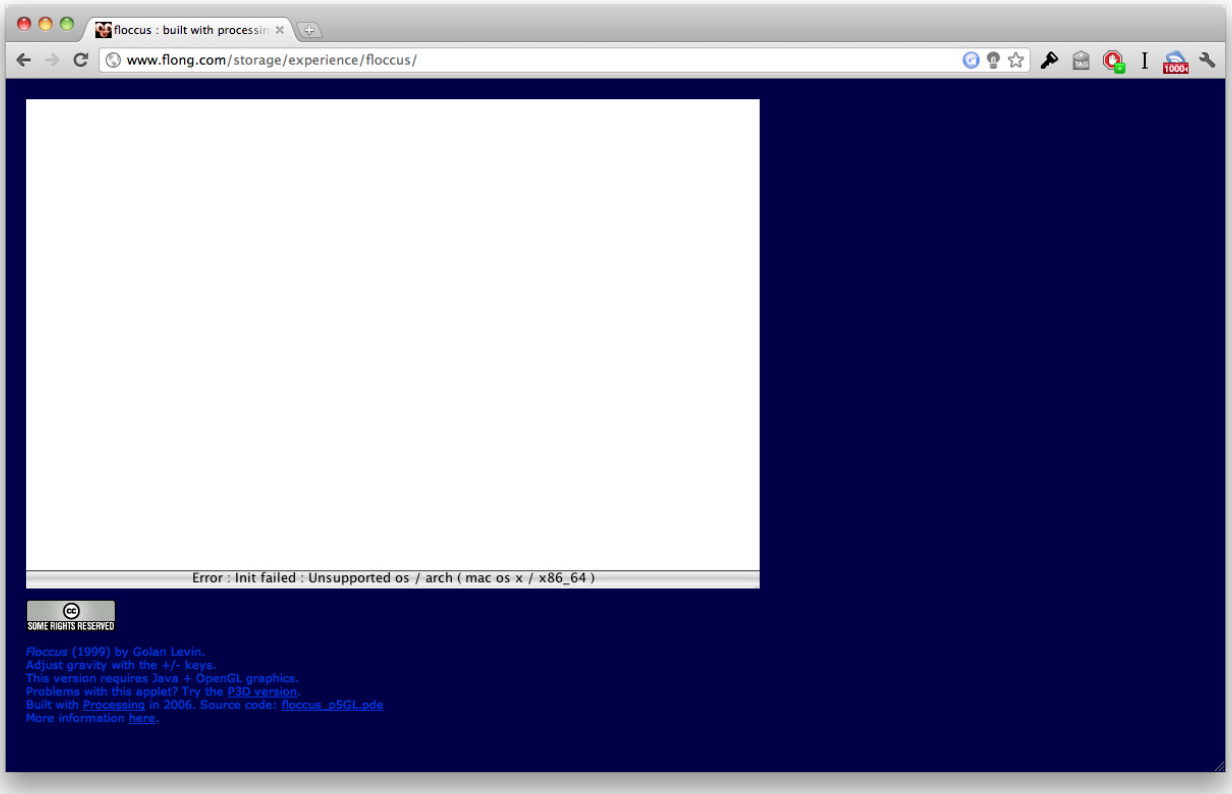

Fig.3 Obsolecent Java Applet of Levin's *Floccus*

11 The popular open-source programming language and IDE developed by Casey Reas and Ben Fry. http:// http://processing.org/

longer exists from the viewer's perspective. Without action, obsolescence creates an air of mythology – an inaccessible history. In the case of Floccus, the responsibility of maintenance and care of the work fell upon the artist. Levin expresses frustration that time normally devoted to creating new work is instead spent repairing old projects (G. Levin, personal communication, March 11, 2011). This example is illustrative of the predominant imbalance of responsibility among the stakeholders in the new media community. Until now, there has not been an ArtBase policy for the repair of works – in effect placing the burden of longevity on the artist. Filling this need is perfectly aligned with Rhizome's mission of support, here, affording the artist space to engage new material.

Lastly, we will explore physical degradation, a term that refers to the deterioration of a physical component of a work. While traditional materials may often outlive the artist, new media is physically challenging. This is relevant not only to delicate storage media, but also works that may involve a physical component that contains digital information. There are many works contained in the ArtBase that are not entirely digital and involve some physical component. For the institution that possesses infrastructure for the storage and preservation of physical collections, this problem does not present any significantly unique challenges. Physical objects, however, fall outside the scope of the ArtBase collection policy. As an online archive, the storage and preservation of any tangible objects is currently outside Rhizome's institutional capacity. This limitation creates the challenge of how to best document and preserve the record of a physical object, such that it A) provides an accurate representation, and B) where applicable could provided a basis for recreation for sake of research or exhibition. A work in the ArtBase that is representative of these challenges is Paul Slocum's Dot Matrix Synth (fig. 4). Here the artist re-wrote the firmware[12] of a dot matrix printer transforming it into a musical instrument. Slocum's code reconsiders the physical potential of the printer, and allows for the harnessing of the printer's naturally occurring mechanical sounds.

"The user presses buttons on an attached control interface to play different notes. As the printer is played, it's also printing a set of images that are programmed into the printer's EPROM with the software. The printer creates sound from the print head firing pins against the paper and the vibration of the stepper motor driving the print head back and forth. To generate different notes, the software adjusts the frequency of the printing process. There is interaction between the images and music. The image dithering patterns fluctuate depending on what notes are played, and the music's volume and rhythmic patterns change depending on the pattern in the current horizontal section of the image." [13]

12 "A permanent form of software built into certain kinds of computer." (OED Online) In this case a printer – the firmware handling the logical operations and communications of the machine.

13 http://www.qotile.net/dotmatrix.html

Works of variable media, such as Dot Matrix Synth, currently exist in the ArtBase solely as documentation; represented by an image, description, and in some cases video. This may suffice for the viewer, yet again, it neglects to address any deeper form of preservation. When considering works of variable media, and mitigating Rhizome's current institutional limitations, a perspective must be adopted that focuses on analyzing what information may be necessary for the future recreation of the work. While the ArtBase cannot currently support a physical collection, there are certainly elements of variable media that can be archived and preserved for restoration in the future.

There is one inherent vice that this paper will not explore: physical obsolescence. This refers to the shifting nature of storage media as it interfaces with computer systems. As posited by Jeff Rothenberg in his 1995 article, "Ensuring the Longevity of Digital Information":

"The year is 2045, and my grandchildren (as yet unborn) are exploring the attic of my house (as yet unbought). They find a letter dated 1995 and a CD-ROM (compact disk). The letter claims that the disk contains a document that provides the key to obtaining my fortune (as yet unearned). My grandchildren are understandably excited, but they have never seen a CD before—

Fig.4 Slocum's *Dot Matrix Synth,* as exhibited at the New Museum of Contemporary Art

except in old movies—and even if they can somehow find a suitable disk drive, how will they run the software necessary to interpret the information on the disk? How can they read my obsolete digital document?"

While this situation is a very real challenge to institutions collecting historic digital heritage artifacts, it is a threat that is not encountered in the materials within the scope of the ArtBase. In nearly every case archival objects are delivered to the ArtBase digitally, thus eliminating any potential for physical obsolescence. Secondly, should there ever be an instance wherein a work of variable media included a form of removable storage media, the likeliness of Rhizome's ability to access its data is high due to the currency of the work collected. Third, the rapid cycles of storage media obsolescence that the 1980-90s witnessed have subsided drastically (Rosenthal, 2010). Whether or not other institutions encounter this issue is entirely dependent on the historic scope of their collection.

INITIAL STEPS: ARTIST QUESTIONNAIRE

Any artist may submit a piece to the ArtBase for consideration of inclusion; in some cases works considered to be of great importance to the field are actively sought for inclusion. This is where the archival process begins. The submission process itself establishes the basics of the work (title, created date, byline, URL, summary, statement, description), content for the display of its record (images, videos, other media), and the specific technologies used (software, programming languages, Internet protocols, etc). Upon selection by Rhizome's curatorial staff, the artist is provided with a link to the ArtBase Artist Questionnaire. This questionnaire provides the artist with an opportunity to explicitly define their desired approach to preservation of the work. This is built on the essential foundation of the variable media questionnaire, which adopts a definition of authenticity defined by the artist. Rhizome is currently developing a more dynamic model of this questionnaire. The technical profile of the work provided during the submission process is used to serve the artist with a more relevant and useful set of questions, generated dynamically from a hierarchical structure. The result of the questionnaire (including not only the artists preservation wishes, but also a more specific technical profile) is automatically added to the work's meta-data.

ARCHIVAL PROCESS: MATERIALS

The questionnaire results and the documentation provided during the submission process, provide the preservation staff with a clear basis for determining the risks present in a work. This in turn informs what materials must be gathered for the work's archival package. In the case of Holmberg's Legendary Account, the conservator would recognize the fact that the piece was a diffusive set of actions within a web service. In this instance, the task is determining the most accurate way of representing the work while taking the preferences laid out by the artist into account. For Legendary Account, scrapping the page

containing each "question" of its contents would be a suitable method. This would provide a static HTML page, and directory containing all assets of the page. While this strategy produces only a representation of the original work, it is arguably the most accurate and closest format. Because these pages are composed of browser-native code, aside from any images or other embedded resources, there is no greater depth of data that could be collected.[14]

JODI's globalmove.us, however, requires a more innovative solution. The greatest risk is present in JODI's use of the Google Maps API. Because this work is entirely reliant on the ability for the artist's Javascript to interact with an external infrastructure provided by Google, the focus should be on simply stabilizing this external infrastructure, in other words, halting innovation for the sake of preservation. Here, an opportunity emerges for institutions such as Rhizome to collaborate with private sector institutions like Google to develop collaborative digital preservation solutions. While it would be unthinkable for Rhizome to host an archived copy of the Google Map database in its entirety, globalmove.us does not use high-resolution images and loads only a small set of geographic locations. A minified and optimized version of the map data used by JODI could potentially be prepared by Google, delivered to Rhizome and hosted within the ArtBase. This model holds potential for many other applications – there are countless external web resources used in many works, some of which (i.e. code libraries) Rhizome can feasibly host for reliable access. Instituting a policy of archiving and hosting such resources would be advantageous, as works in the ArtBase as well as external parties could rely on these shared resources.

Levin's Floccus presents material gathering needs specific to compiled software. Unlike a web page's uncompiled source code, readable by both machines and programmers, once compiled source code forms a stand-alone applet or other form of software, a barrier is created preventing a human analysis of the work. Compiled applications do not allow for the ability to understand the artist's logic, algorithms, and programming style. In a restoration scenario, this information is integral. In the case of Floccus, there are five primary entities that must be gathered to form the archival package: the Processing source code[15], a font file that is used in the piece[16], the compiled Java applet, the compiled P3D Processing Applet, the original 1999 C++ source code, and the compiled software of the C++ version. With the description of the work, the images of its documentation, and analysis of the various formats of source code, there is ample information to inform emulation or reinterpretation in a restoration scenario.

14 Additionally, this presents a valuable argument for standards such as HTML5, which focus on using browser-native features, rather than proprietary plugins. These standards are by their very nature open-source, as the source is always available to the user by simply clicking "view source" in their browser.

15 In the form of a .PDE file, which is readable by the processing IDE, as well as any plain-text editor or web browser

16 This is embedded in the compiled versions, but when running the uncompiled .PDE file, the font file must be present.

With Slocum's Dot Matrix Synth, we are presented with three components: printer, firmware[17], and controller. The firmware and controller are the vital components of the art object, as without Slocum's custom written firmware, the printer would function as ordinary, and without the controller there would be no means for initiating the actions defined by the firmware. The problem remains that the controller and printer are physical objects. It is not feasible for the ArtBase to preserve the entirety of this particular art object as a functional variable media art object. Rather, the preservation approach of such works is an attempt to provide not only the best representation of the work in its original context, but to analyze the work in terms of its components and preserve whatever components fall within the scope of the collection policy. For example, while the controller is a physical object designed and built by the artist, it is composed of common electrical components. A schematic of this controller provides a precise blueprint for its recreation. Seen this way, Rhizome is left with the task of preserving the code and electronic schematic documentation, which together provide a full depiction of the artist's handling of these ephemeral elements and a blueprint for emulation.

17 Which originated as source code written by the artist, and now exists on an EEPROM chip inside the printer.

ORGANIZING AND MONITORING THE COLLECTION

Before considering strategies of restoring dysfunctional works, the initial problem is how to accurately and efficiently identify the need for restoration. With a rapidly growing collection currently containing over 2,500 works, manually monitoring the functionality of every entity in the ArtBase is unrealistic. Here two strategies will be explored for monitoring and identifying problems requiring preservation attention: automated scripts and crowd sourcing. Additionally, the ArtBase's metadata schema will be offered, as it plays a key role in allowing for not only the searchability and browsability of the archive, but also in streamlining the monitoring of obsolescence.

Although the ArtBase recently adopted a new collection policy that accepts only archival objects, it continues to suffer from the past acceptance of "linked objects." These works exist external to the ArtBase, hosted on the artist's server, or hosted by a third party such as a gallery, or commissioning organization. In such cases, Rhizome has no control of the sustained access to these works; they exist in the ArtBase solely as catalog entries. If the artist removes the work from their server, stops paying for their hosting, or changes the URL, the work ceases to exist in the ArtBase. Efforts are underway to transition these works to full archival entries hosted by the ArtBase, but they risk disappearance in the meantime. Fortunately, verifying something so simple as a URL can be fully automated, as the difference between a dead URL and a live URL

is a machine-readable difference. Rhizome put in place a server-side Python script that crawls the ArtBase, and produces a report of all linked objects that are pointing to defunct URLs. Although this strategy is effective, it will no longer be relevant once the ArtBase completely transitions to an archival model.

Scripting the monitoring of anything more complex than a dead URL requires greater infrastructure and a more nuanced approach. This is accounted for in the design of the ArtBase's metadata schema. The "format" element (derived from Dublin Core) is used to describe the specific file formats, programming languages, and technologies that are included in a work's archival package. This is made powerful through the use of a controlled vocabulary, carefully assigned by a preservation specialist and based on the National Digital Information Infrastructure & Preservation Program's Format Descriptions[18]. This affords the capability to identify every art object in the ArtBase that shares a format found to be obsolescent, or any other technical components of a work causing incompatibility problems. The problem remains however that issues of browser support and obsolescence most often do not manifest themselves in a discrete manner that can be identified by a script; there is no way to write an algorithm that asks to search for anything that "doesn't look right".
So how might one effectively identify such issues, aside from manually monitoring the collection? In the context of the ArtBase, the most effective means of identifying these complex problems is in fact a simple human one. Providing users of the ArtBase with a simple and helpful means to report problems with an art object offers an effective means for identifying dysfunctional works. Once a user has flagged a work as being in some state of dysfunction, it can be investigated for the root of the issue. If the issue is in fact found to be one of obsolescence that may be affecting other works in the ArtBase, the "format" element can be used to identify other works. Designed for optimal interoperability, many of the ArtBase schema elements derive directly from Dublin Core and CDWA-lite. This allowed for efficient contribution by Rhizome to the Getty Union List of Artist Names – a major step in further establishing the authority of the medium (see appendix).

RESTORATION: STRATEGIES

Once a dysfunctional artwork is identified, the next step is to analyze the root cause and select the appropriate approach to restoration. There are three commonly acknowledged forms of restoration: emulation, migration, and reinterpretation. This section will explore these established methods within the context of the previously discussed works. Through this theoretical exploration, and the findings of the Variable Media Network's case studies, an analysis of how relevant these methods are to the ArtBase will be provided.

Emulation is the simulation of the architecture and behaviors of an old computer system, within a

18 www.digitalpreservation.gov/formats/fdd/descriptions.shtml

contemporary system (Depocas, 2003). For instance, if an art object will no longer run on contemporary operating systems, a piece of software may be written that emulates the environment of the work's original operating system. This strategy is quite efficient in the sense that one emulation effort can restore functionality to multiple works, providing a functional environment for any works that originally shared the emulated platform. Emulation however, introduces simply another piece of dated software. While an emulator restores access to an art object, it is only a temporary solution – with time the emulator itself will become obsolete and unusable on contemporary computer systems. While case studies have shown that emulation is in fact quite effective at producing an aesthetically authentic iteration of art objects, these studies have also shown that it is fact quite a in-depth process best suited for circumstances that justify a high level of investment in a short-term solution (Rothenberg, 2006). This suggests that emulation may be antithetical to the scope and context of the ArtBase. Rhizome at once benefits and is challenged by the context in which the ArtBase is delivered. The case studies of the Variable Media Network focused on emulation in scenarios where a work was often tied to some original form of physical display. Yet, works in the ArtBase will always be delivered to whatever computer environment is used by the visitor.

Thus it follows that the prerequisite for restoration efforts is not simply for a work to function outside of its original format, but to a broad base of rapidly evolving web browsers and operating systems.

Deprecation and obsolescence is a necessary evil for an evolving Internet. The World Wide Web Consortium and its member organizations[19] develop best practices and put these into practice through choosing what languages, tags, and syntax are natively supported by web browsers. Yet, software efficiency and the politics of emergent web standards is a concern secondary to our goal of having the ability to properly support a chronological legacy of net.art. This establishes the need for a "museum quality browser" – one that runs on contemporary infrastructures and provides legacy support for archaic protocols and markup of the early days of Internet art. Rather than adopting a policy of deprecation, such a browser would be built on a development philosophy that is additive, providing native support for emergent standards and preserving support for the old. Building upon open-source frameworks such as WebKit[20], or Gecko[21] would be ideal as they come from a rich discourse and community of developers. This model is flawed however, in the sense that it would require the user to download and install an entirely new browser. As nearly all commonly used web browsers (i.e. Google's Chrome, Apple's Safari, Mozilla's Firefox) are built upon the aforementioned open source frameworks, it would be ideal to initiate collaborations with these parties, so as to aid in the development of more preservation-friendly development practices. The realization of this model as a browser extension or feature native to these

19 http://www.w3.org/Consortium/Member/List

20 http://www.webkit.org/projects/goals.html

21 https://developer.mozilla.org/en/Gecko_FAQ

browsers would be a more sustainable model, as it asks less of the visitor, while theoretically offering the same result. While emulation is a term not often used when speaking of web content, that is essentially what the model proposes – an environment that will provide support and access to art objects that are otherwise inaccessible on contemporary systems. However, while previously it was posited that emulation was not a viable solution for the ArtBase, this model is feasible and sustainable, as it is provide a singular solution for the majority of the collection.

Migration is a strategy that suggests converting the digital assets of an art object and its archival package from obsolete formats, to contemporary formats. For example, if the .JPG image format was in the beginning stages of deprecation (a drastic example), works that employed use of this image format would be converted to a more current and stable format. While migration does present a viable solution for the management of digital assets, it assumes a high level of access and interoperability. For example, migrating a format such as .JPG is viable only because it is a format that is interoperable with many different forms of image editing tools. Lossless migration from .JPG to a new standard does not require access to any sort of source code, so long as there are tools that can interpret it. This approach becomes more challenging when considering the whole of the ArtBase, as many works include less interoperable proprietary compiled formats, such as Shockwave Flash files (.SWF), and require access to specific editing software (Adobe Flash) and original source files (.FLA, Actionscript) in order to approach migration. While migration will remain a fundamental component of preservation, within the context of the ArtBase, it will over the long-term be best suited for application to simple assets such as images, sound, and video.

Where migration offers a simple process of continual upgrade, works whose primary form is a compiled piece of software, such as Levin's Flocuss, require a more involved process – referred to as reinterpretation (Daniels, 2009). When a piece of software no longer runs on contemporary infrastructures, one cannot simply convert it. Reinterpretation calls for delving into the uncompiled source of the software, and repairing whatever is the root cause of its obsolescence. In some cases this may be as simple as altering the format of the compiled software, while in others it may call for a fundamental re-write of the software's source code. In such cases, this is only made possible by having access to the software in its uncompiled format. In the most drastic of situations, documentation of the functional work, along with analysis of the work's source can offer a path to creating a faithful reinterpretation. The sense in which emulation is not feasible for the ArtBase is applicable here – the thought of distributing emulators for visitors to the ArtBase to download in order to run the various software based works asks much effort on the users part.

PLANNING FOR THE FUTURE

An area yet to be fully explored by Rhizome and the ArtBase, is the legal complexity of preserving source code. While artists often negotiate rights to retain source code, or masters (Rinehart, 2006), it is in Rhizome's best interest to integrate into the ArtBase's Collection Management Policy the stance that if a work is to be included in the ArtBase, source code, masters, any materials necessary for preservation must be supplied. Because the ArtBase is an artist driven archive, this policy can be conveyed at the point of entry. In addition to providing an appropriately flexible potential for preservation, preserving a work's source code also opens the question of whether such material is to remain private, or if it can be allowed to enter the publicly accessible archive. The ArtBase is to a great extent an educational tool. Many institutions subscribe to the ArtBase in order to offer their students full access to its contained history. Source code is inarguably a component that is significant to historic research and education. As suggested by Rinehart in *Nailing Down Bits: Digital Art and Intellectual Property*:

"Organizations that commission digital art are encouraged to include mechanisms for ensuring that their investment serves the public while protecting the artist. For instance, university galleries might commission art and require that the resulting digital work be open for re-use by local students."

Rhizome should consider the development of an opt-in open-source component to the ArtBase that allows students, professors, researchers, and technologists to "fork" an artist's code for re-use. This follows the belief that obsolescence is steered by use, and re-use breathes new life into creative works.

A major wealth of material not collected by the ArtBase is the ephemera produced by the artist. Whereas the artist working with physical materials produces ephemera such as sketches, plans, notes, unfinished works, and studies, these materials are typically not collected until after an artist passes, or late in their career. For the artist working in an entirely digital computing environment, what is the likelihood of these peripheral documents surviving? During the life of one artist, many computers will come under their command, and while their finished works may persist on servers and in archives, what is to come of the ephemera contained on the studio environment of their hard drive? By definition, ephemera fall outside of the scope of most collecting institution's immediate interests. It simply constitutes far too much material when considering the sheer quantity and the inability to predict what will be worthwhile. It is undeniable that some day this material will be valued. A unique example where this was executed successfully (through a combination of good fortune, and expert digital forensics) is the Rushdie archive at Emory University's Manuscript and Rare Books Library (MARBL). Here they preserved and emulated the personal computer of author Salman Rushdie. While Rushdie was not a digital artist per se, the computer was in fact his studio environment. MARBL preserved the ability to observe Rushdie's digital manuscripts, drafts, notes, sketches,

and correspondence. While this may seem unrelated to the nature of the ArtBase's collection and Rhizome's mission, it is a teachable moment in the value of digital ephemera. What provisions can be made to ensure that future generations will have access to not only preserved art objects from our time, but the ephemera produced by these artists? It is in the best interest of stakeholders to strive for developing tools for the artist that will allow for some form of self-preservation, as well as integrating these materials into the scope of interest.

For Rhizome and other collecting institutions and repositories, the path forward is clear: interdisciplinary collaboration. Institutional and disciplinary boundaries often keep innovation and progress within their respective silos of knowledge. Within the field of technology there are powerful stakeholders far outside of the art world and museum community, who have made advances and built tools incredibly useful to collecting institutions such as the ArtBase. It is vital to expand collaboration and communication, and for institutions such as Rhizome to seek consultation from such fields. The model of collaboration forged by the Variable Media Initiative is a scalable one. The VMI was intentionally composed of diverse institutions at the top of their respective domains, be it Internet art, performance art, or collections of variable new media. Each institution offered their field specific knowledge, resources, tools, innovation, and research. This aggregation of wisdom is necessary on a broader scale in order for collecting institutions such as Rhizome to move forward without replicating the efforts of parallel domains, such as digital asset management, computer science, and library science.

In 2002, Richard Rinehart concluded his paper "Preserving the Rhizome ArtBase" with the following statement, "Rhizome will make a unique, significant and feasible contribution to digital preservation efforts by proposing and testing solutions for metadata and policy as outlined above." In a moment that sees the ArtBase transitioning to a truly standards based archive, this statement remains to be true. Rhizome remains to be one of the few organizations dedicated specifically to the sustained preservation of and universal access to the cultural history embodied by Internet art and variable media. It is hoped that this paper will not only serve to document this moment, but also provide guidance as Rhizome moves forward with future endeavors.

APPENDIX

Title	Title of work
Byline	Name of artist
Created Date	Date of the work's creation
Summary	A brief (approx 100 word limit) summary of the artwork
Statement	Artist statement; about the specific artwork or the artists' overall oeuvre. (no word limit)
Description	A full description of the artwork (no word limit). Formal or otherwise.
URL	The permanent URL of the work's public record in the ArtBase
Approved Date	Date the work was approved for inclusion
Tags	Artist defined keywords
Other Artists	Name of the artist and their role in the production of the artwork
Support	Support or funding artist has received for the work (title, benefactor, amount)
Technologies	Controlled Vocab of tech implemented in the art object
Format	The technologies and formats included in the archival package
State Ed.	State, version or edition of the work
Collective	"If this Artwork was created by a collective, please provide the collective's name"
Exhibitions	title, curator, link, location of exhibition
Tech details	An overview of the technical aspects of the work
License	All Creative Commons variants, All Rights Reserved, BSD License, Public Domain
Readme	Administrative record of the archival object.
Notices	Metadata administrative change log.

Fig.6 Artbase Meta-Data Schema

ArtBase	Dublin Core	CDWA-lite
Title	Title	Title (2.1.1)
Byline	Creator	Name of Creator (4.1.1.1)
Created Date	Date (Created)	Display Creation Date (12)
Description	Description	Descriptive Note (17.1.1)
Tags	Subject	Classification (16.1)
Other Artists	Contributor	Name of Creator (4.1.1.1) with Role Creator (4.5)
Technologies	Type	Term Materials Techniques (8.1.1)
Format	Format	Classification (16.1)
State Ed.		Display Edition (9.2)
Collective	Contributor	Name of Creator (4.1.1.1) with Role Creator (4.5)
Exhibitions	Publisher	Label For Related Work/Group/Collection/Series (19.1.3)
License	Rights	Rights for Work (20)
URL	Relation (Has Part)	Location/Repository Set (14.1)
Title	Title	Title (2.1.1)
Byline	Creator	Name of Creator (4.1.1.1)
Created Date	Date (Created)	Display Creation Date (12)
Description	Description	Descriptive Note (17.1.1)
Tags	Subject	Classification (16.1)
Other Artists	Contributor	Name of Creator (4.1.1.1) with Role Creator (4.5)
Technologies	Type	Term Materials Techniques (8.1.1)

Fig.7 ArtBase crosswalk with Dublin Core and CDWA-lite

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