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“Do You Want to Save Your Progress?”: The Role of Professional and Player Communities in Preserving Virtual Worlds

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Abstract

Almost since the inception of the industry, the player community has been instrumental in preserving video games and other variable media art. Drawing on a combination of primary and secondary sources of information, including the Preserving Virtual Worlds project (an academic investigation into viable models of preservation for videogames and 3D virtual worlds based on a series of archiving case studies) and the results of a game documentation survey conducted by Donahue, we examine how players are taking responsibility for collecting, managing, curating, and creating long-term access to computer games. Because our interest lies with the contact zone between players and information professionals, we also describe and analyze how we and other scholar-archivists are collaborating with or relying on the user community to preserve virtual worlds, with an eye to how these relationships might eventually be codified within a larger preservation framework.[1]

> Production, distribution and consumption of all forms of digital information: text, music, image, video: have all been democratised. So why should the curation of these be any different? (JP Rangaswami)

> What is an amazing cultural shift — I’m probably exaggerating a little bit — but what we’re looking at is that artworks are going to be preserved because seventeen-year-olds are doing the work of preserving them. (Christiane Paul, Curator of New Media, Whitney Museum (Echoes of Art Symposium, 2004))

> Archives . . . are about dynamic recordmaking, and remaking, re-remaking, over and over again, without end, rather than the traditional record-keeping, looking after and keeping safe some fixed records product as a sacred artifact. (Terry Cook, Introduction to Verne Harris, *Archives and Justice: A South African Perspective*, [Harris 2007])

Introduction

In 2006, Margaret Hedstrom and a team of researchers at the University of Michigan published the results of an experiment exploring how users evaluate the authenticity and usability of computer games and other digital materials that have been preserved through multiple methods. The study found that users tended to prefer playing emulated and migrated versions of a popular 1980s-era computer game known as Chuckie Egg over the original version. Arguing the importance of the user's perspective in archival decision-making, the authors begin and end the paper with a call for further research into the “needs and preferences” of the user community [Hedstrom et al 2006]. The purpose of this article is to develop this line of inquiry by drawing on a combination of primary and secondary sources of information, including our experiences with the Preserving Virtual Worlds project (an academic investigation into viable models of preservation for videogames and 3D virtual worlds based on a series of archiving case studies);[1] the results of a game documentation survey conducted by Donahue on the preservation practices of the videogame industry and the player community; user-generated game resources, hacks, mods, and ports;[2] and the scholarly literature on game studies, archives, and digital preservation. Where we depart from Hedstrom and her colleagues is in how we position the user within the preservation system. While their assumption is that users are primarily consumers of digital information, ours is that they are also avid custodians of it. To frame the issue in archival terms, we see players taking responsibility for collecting, managing, curating, and creating long-term access to computer games. Because our interest lies with the contact zone between players and information professionals, we will describe and analyze how we and other scholar-archivists are collaborating with or relying on the user community to preserve virtual worlds, with an eye to how these relationships might eventually be codified within a larger preservation framework.

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Participatory culture provides one obvious context in which to consider the rise of the player archivist and preservationist. In recent years much has been made of the allegedly stark contrast between amateur and professional culture, and those writing about it tend to structure the conversation in markedly polemical terms. While proponents of amateur culture extol the democratization of the means of production, opponents denounce the decline of subject expertise, certified credentials, and institutional standards.[3] This paper attempts to shift the focus and substance of the debate in two ways:

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- First, by framing amateur and professional culture in terms of content *preservation* as well as the more customary content *creation* (user-*preserved* and *curated* media in addition to user-*generated* media). Drawing on examples from the creative/expressive domains of computer games, interactive fiction, and variable media art, we argue that the production and dissemination of fan-made mods, game cracks, and homebrew ports are frequently not only creative (or piratical) activities, but also preservational ones. While this position differs from that held by most in the recordkeeping professions for whom the integrity, fixity, and accuracy of digital information are the cornerstone of any responsible preservation program, one of our objectives is to situate the transformational model within the context of cultural heritage studies more broadly, where it has been legitimated in a variety of disciplines. It finds expression, for example, in phrases such as “permanence through change” (museum studies); “transformission”: transmission + transformation (textual scholarship); and “preservation through adaptive reuse” (architecture).[4]
- Second, by demonstrating that the relationship between professional and amateur archivists of virtual worlds is one of reciprocity and mutual influence. Even those, like Richard J. Cox, who acknowledge the increasingly important role of citizen archivists in the information age tend to assume an asymmetrical relationship between them and their professional counterparts [Cox 2009]. Cox presupposes a uni-directional transfer of knowledge from professional to amateur, with the former “advising,” “assisting,” or “educating” the latter.[5] When it comes to the preservation of computer games and related artifacts, however, both sides are in possession of significant expertise. Moreover, the borders separating them are remarkably porous: the contributors to the Mystery House Taken Over Project, for example (discussed below), might be variously categorized as artists, gamers, developers, scholars, and preservationists. A single individual — or a single community — contains multitudes.

The article is divided into five sections: Part I overviews the primary risks to videogame longevity, including hardware and software obsolescence a mere 5–10 years after a game’s initial release. Part II summarizes what actions are currently being undertaken to preserve videogames by three communities of practice: the videogame industry, the

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player community, and the information professions. In order to assess the contributions of the first two communities, Donahue administered two surveys designed to reveal where professional and amateur preservation activities intersect with and deviate from one another. Part III introduces the user paradigm of preservation through adaptation, drawing on the example of *Mystery House* [Williams 1980], the first text adventure game to include graphics. This paradigm, we argue, shapes (and is shaped by) a view of authenticity that values continuity through change and that conceptualizes an art object as an entity whose ontology is fulfilled through the process of adaptation. By this logic, a game is paradoxically more faithful to itself as it is modified and transformed by developers and successive generations of players.[6] Part IV examines patterns of interaction between communities of practice. We are particularly interested in those instances where the transfer of a game's stewardship from one community to another corresponds with a shift in preservation strategies, for example from a "data-centric" approach of porting or modding to a "process-centric" approach of rendering the original object through emulation or virtualization.[7] Through an examination of Will Crowther's *Colossal Cave Adventure* (the first text adventure game)[8], William Gibson's *Agrippa* (a work of variable media art) [Gibson et al 1992], as well as a number of secondary sources, we also attempt to identify some of the principles that underlie the selection of significant properties in player mods and ports. Part V derives a set of recommendations for game preservation from the foregoing analysis. A coda to the paper pays tribute to the player community.

Risks to Videogame Longevity

While paper records remain potentially accessible for decades and even centuries with no intervention, videogames are subject to hardware and software obsolescence a mere 5–10 years after their release. Prior research into the preservation of electronic records has largely focused on static files created on personal computers, which present far fewer challenges than an interactive piece of software, often designed for use on a proprietary system.

Hardware obsolescence: The original console or computing platform used to run the game may cease to be supported or even available in the aftermarket.

Software obsolescence: The original software needed to run the game — operating system, drivers, frameworks — may lose support, cease development, and become incapable of running on future hardware/software configurations.

Scarcity: Some video games are produced in limited quantities, and are subject to the dangers of media decay.[9]

3rd party software dependence: Once a game platform becomes obsolete, emulation may be the best method of providing access. Currently, however, most emulators are developed by the game community and are of questionable legality. They are also typically created without the benefit of the original specifications, and are themselves at risk of becoming obsolete.

Complex, proprietary code and an associated lack of documentation: Videogames are generally released as compiled binaries with no documentation of the compiling process, or even the programming languages used. Not having access to the source code or language specifications makes migrating or emulating software far more difficult. It's a magnification of the format identification issue for stand-alone, static files.

Authenticity: The elephant in the digital preservation room — proving that a digital object is what it claims to be, free from tampering or corruption. Video games enjoy many versions between the first prototype, the official release (on multiple platforms), and cracked or otherwise altered unauthorized editions. Especially for older games, the only extant copy may exist in a fan-run web repository, making the authenticity impossible to establish.[10]

Intellectual property rights: The game development industry is highly creative and competitive, leading developers to be very jealous of their intellectual property. Most have instituted extremely draconian shrink-wrap licenses reflecting this. And yet, once a game is no longer actively marketable, they are unlikely to respond to inquiries about licensing for it.[11]

Significant properties: What are the significant properties of a game that must be maintained with each

transformation/preservation action? How important are font size and color palette? What about the speed of text scrolling or sprite movement? How faithful must we stay to the original code? Is it enough to save a video of gameplay, or must we save the interactivity? Do we need BOTH? These are essential to define, as they play a major role in determining authenticity.[12]

Context: Although this isn't an immediate threat to the preservation of games, building contextuality is important to creating understanding for future users. This is truer for video games than many other record types because, as technology advances, game players who have only been exposed to the latest and greatest may be apt to play an older game and say, "so what?" even though the game might have been revolutionary for its time.[13]

What's Being Done?

To determine what *should* be done (see the "Recommendations" section), we first need to understand what activities are currently being undertaken to preserve videogames. To do this, two surveys were constructed: one for game developers, and one for game enthusiasts. The surveys were distributed through the International Game Developers Association's white paper, presented at the Game Developers Conference, announced on the Grand Text Auto blog, and publicized among known developers and gamers including members of New England Classic Gaming [Montfort 2009].[14] Responses were collected and analyzed using the SurveyMonkey service, and questions were structured as multiple choice, free text, or a combination of the two. Very little demographic data was collected, in order to encourage participation by ensuring anonymity. 5

Industry response

Total respondents: 48

Completion rate: 33.33% (16 respondents)

Respondents with > 50 employees: 26

Forty-eight individuals from the videogame industry responded to the survey, but only 16 answered every question. Of the respondents, 26 were from companies that had 50 or more employees, and only 6 of these made it beyond the question, "Have you considered establishing an archives/records management program?" Nine of the 26 responded that they did have a formal program, 15 did not have one, and 2 skipped the question entirely. Those with formal programs, in both smaller and larger companies, grouped their records according to project and/or type of asset (e.g. code or graphic). **Figure 1** shows the main divisions of records included in archives/records management programs. 6

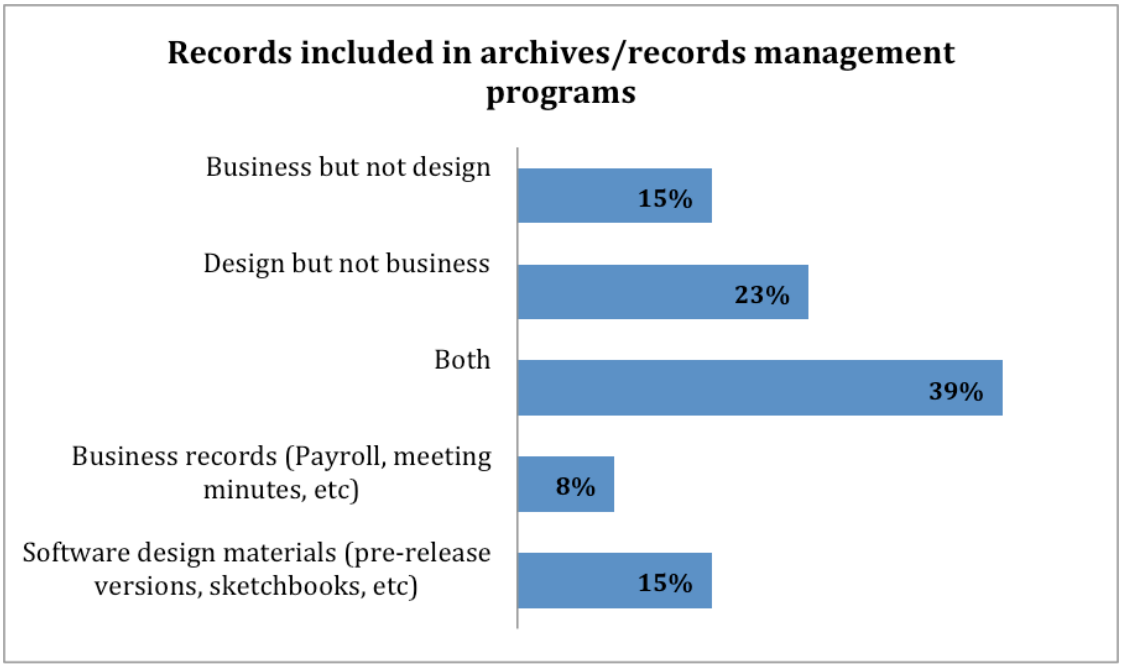

Figure 1. Records included in archives/records management programs

Comments to this question showed a range of disorganized preservation activity. Some companies indicated using a wiki to manage and preserve their records, many referred to a version control system or code repository, and a few mentioned nightly backup tapes without elaborating on the content of those backups. The most promising comments were from respondents who claimed they used configuration management (CM) processes and policies for all of their major game builds, though not for individual developer materials. 7

According to Jessica Keyes, CM "identifies which processes need to be documented" and tracks any changes [Keyes 2004, 3]. Wikipedia expands on this, noting that it "identifies the functional and physical attributes of software at various points in time and performs systematic control of changes to the identified attributes for the purpose of maintaining software integrity and traceability throughout the software development life cycle." [15] Unfortunately, in the very same question, the same respondents admitted that many, if not most, developers have no CM training. 8

Using a code repository or asset management system is certainly an important part of a good CM plan. And yet, although they were mentioned in an earlier question, only 50% of respondents said they utilized them when asked specifically. 9

Although 2 respondents said that they did use records schedules, most free-text responses regarding how permanence is determined displayed a fairly casual attitude towards preservation. There were many references to item types that were necessary or reusable being kept, while everything else was tossed, and to materials only being kept for successful games. Some companies retained related documentation, while others did not. Storage environments (**Figure 3**) ranged from enshrining physical records in an off-limits closet to a hard drive stored under a developer's desk. The word "whim" in reference to an individual deciding the fate of records was used more than once. 10

In summary, there seems to be a tendency within the game industry to make preservation decisions at the level of the individual developer, with no official guidance. When Donahue asked the question of a Garage Games developer at Foundations of Digital Games, he responded, "[laugh] We don't. Other than the source code of a game that ships, we don't care. I just had someone looking for annotated versions of our tools and we don't have them." To be fair, this is explicable. Game developers tend to work with a fixed deadline: the majority of their income is made in the holiday season, so they need to get releases out early in the 4th quarter. They also operate on a finite budget, which tends to mean fewer programmers working more hours–leading to everyone working at too breakneck a pace to give a thought to what happens to any of the interim products. 11

The survey also asked respondents to indicate what kinds of digital and analogue objects they were preserving (**Figure 2**). Of the materials listed in the questionnaire, all categories were saved by at least one company, except for “Game magazines/clippings files.” The most popular categories were source code and compiled binaries, as well as game assets and artwork, with 85% of respondents reporting they preserved each of these item types. Following closely behind at 77% each were design documents and tools developed to support game creation. 12

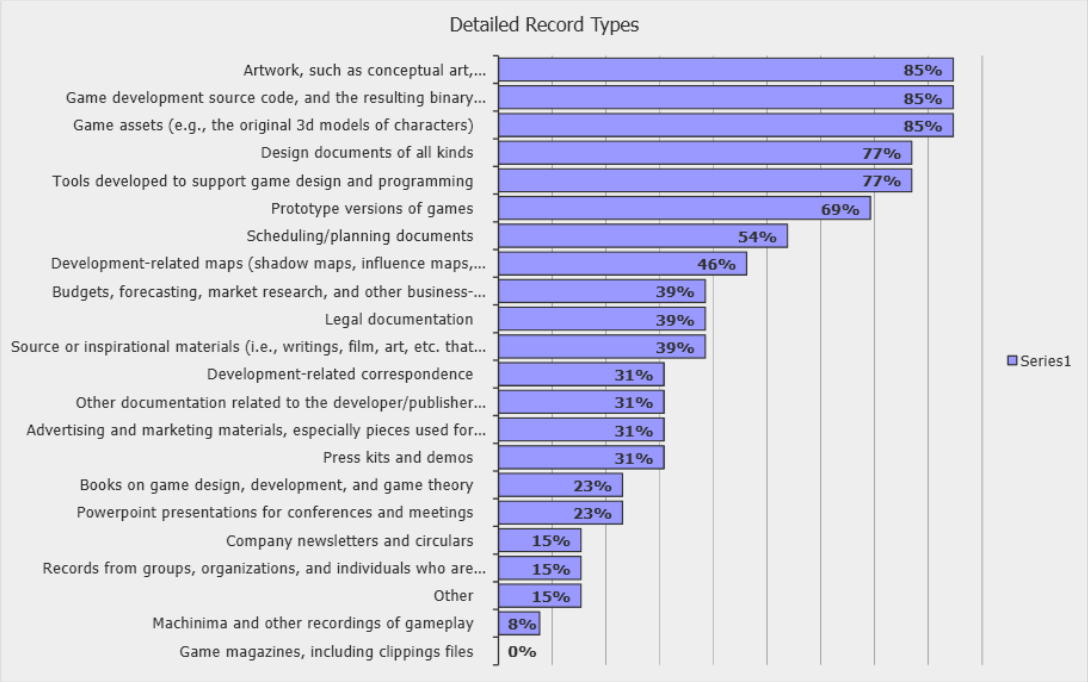

Figure 2. Detailed Record Types: Industry

Only 8% saved recordings of game play or machinima (video productions using a game engine as the recording/acting mechanism). This finding contrasts significantly with the practice of game players. At the time of this writing, a YouTube search for “speed play game” yields 14,800 videos and “game play demo” yields 73,100 results. One example of a user community project, “C64 Longplays,” [16] offers 270 videos of end-to-end game play and an additional 199 more generalized videos of “the most popular or obscure” games. 13

Of the 12 respondents who answered the preservation tactics question, 7 reported simply saving the files in their original format, 1 migrated to an unspecified preservation format, and 3 transformed files on demand if the game was needed for another reason (such as a re-release) in the future. One respondent went so far as to say that once a game’s platform is gone, the software is, too. Emulation was referenced only as a test platform during development. Responses to the description questions revealed that metadata tends to be captured as unstructured text rather than using a schema or authority list, if it is done at all. 14

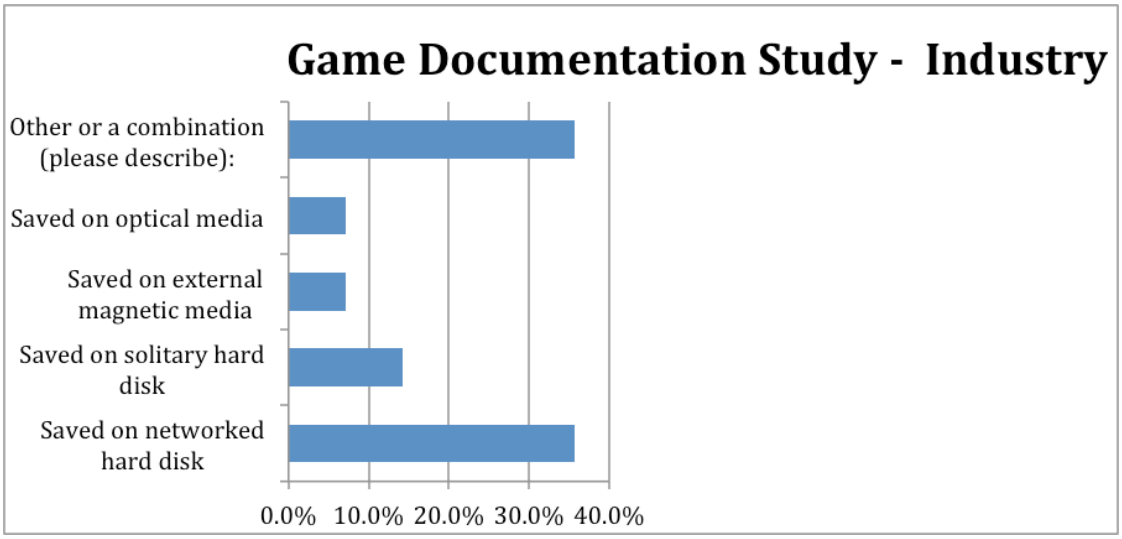

Figure 3. Game Documentation Study (Industry): File Storage

Additional comments support the interpretation that the survey responses reveal a lack of industry interest in preservation. Many game companies simply are not concerned with their games beyond the development lifecycle. If the results of this survey reflect the practices of the industry at large, we are in serious danger of losing large chunks of our cultural heritage. The concept of “benign neglect” can be applied safely to paper records and even some analog audiovisual media — but apply it to digital objects and they will almost certainly end up in the dustbin as soon as they go out of active use. 15

Community Response

Total respondents: 62
Completion Rate: 87%
Respondents with preservation experience: 19

Luckily for future historians, gamers, and students, the player community is very active in preserving the software and artifacts of the games they love. If enthusiasm can be inferred from response rate, the contrast between the community and industry surveys demonstrates very different levels of interest. Recall that 16 people (or 33%) of those answering completed the industry survey, a decent rate of response, according to some. The community, on the other hand, completed the survey 87% of the time, generating 54 full responses, with numerous people emailing that they wished they’d had a chance to take the survey before it closed. 16

Illustrating the diversity of the community, respondents were split between exclusive collectors of officially released material, and those who collected unreleased as well. Systems that interested them ranged from the Vectrex (1982–84, a home system with built-in display, that used vector graphics rather than the more common raster graphics) and Pong (1972 and after, a single-game console originally popularized in bars) to the PS3 and Wii. Thirty percent collected ephemera, and about half used emulators to play games for systems that interested them. The free text comments on the emulation experience were rich, and, with emulation being a primary access method for obsolete systems, deserve further exploration and analysis in a later study. 17

The enthusiasts were also asked which websites they regularly visited and/or contributed to, with 77% partaking in both activities. These websites represent a very valuable preservation contribution by the game community. Sites like GameFAQs.com, MobyGames, and Home of the Underdogs (before its unfortunate demise) provide metadata and context information at a level many cataloguers would envy. This data is essentially peer reviewed, as there are scores of well-informed visitors constantly viewing and updating it. Some sites have a formal moderation system for quality control. 18

Nineteen of the respondents had engaged in preservation activities beyond website participation. The most common activities were contributing to an emulator, imaging disks, and restoring/refurbishing hardware (Figure 4). More unusual activities were designing a preservation architecture,[17] writing preservation guidelines for developers, and curating game related exhibits. Additionally, three of the respondents put their collections to good use, by releasing previously unreleased games to the public. Whether this was as a ROM or on physical media is unclear,[18] but both have been known to happen. Mike Tyson's Intergalactic Punch Out for the NES was released as a ROM,[19] *Star Wars Ewok Adventure* for the Atari 2600 was released in a limited run of 30 cartridges.[20]

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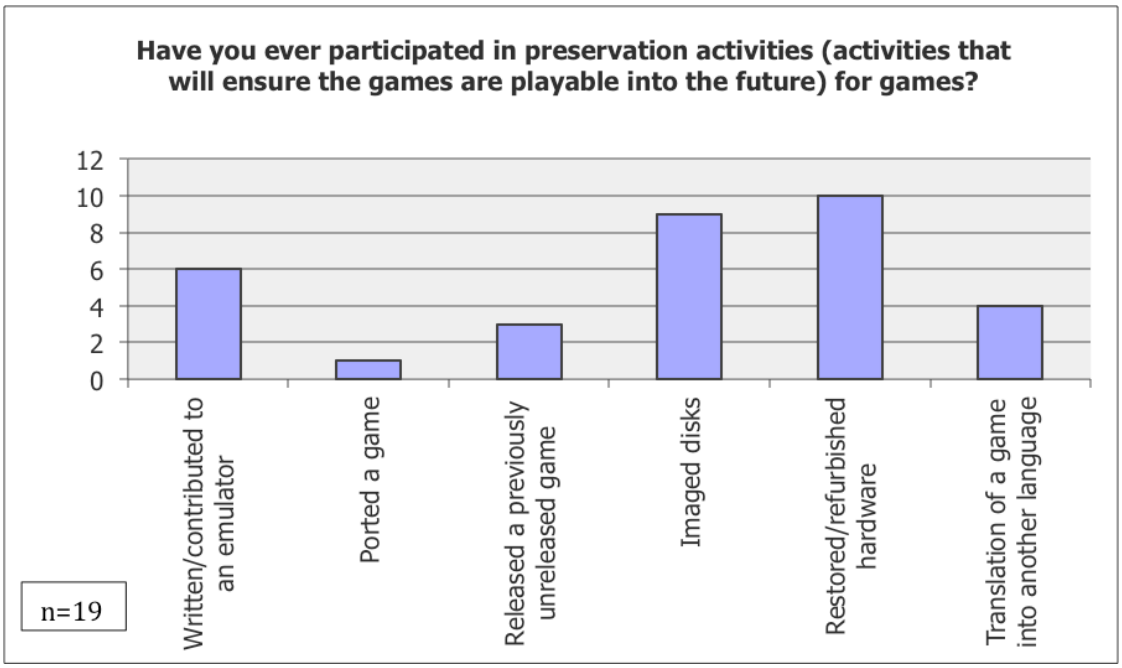

Figure 4. Player Community: Preservation Activities

Information Professionals

The archival literature has, relatively speaking, a dearth of preservation-centered articles for interactive objects. InterPARES (International Research on Permanent Authentic Records in Electronic Systems) is a series of projects investigating problems related to the "authenticity, reliability, and accuracy of electronic records throughout their life cycle." [21] While InterPARES2 dealt with "Experiential, Interactive and Dynamic Records," its focus was on files generated by artists, musicians, and scientists, rather than software. Regardless, a repository looking to preserve videogames would do well to follow the "Preserver Guidelines" laid out in the Project Book[22].

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In particular, the oft repeated mantra (in the realm of e-records) of getting involved early in the lifecycle process is important to game preservation. The dangers of obsolescence make it extremely useful to have the source code for games of enduring value. Due to the nature of development and the rapidly changing market, raw source code is more likely to be available before a game is officially released – before it has been compiled into the executable programs we run on our systems at home. Taking a disk image from an official release – making a hardware-independent copy – only provides the binary files, and these are difficult to migrate to other formats should it become necessary. The trouble with binary files is that they obscure the underlying code and are difficult to impossible to decompile. If, however, we have access to the source code, it would allow an enterprising programmer to change small amounts of the code to create a source port to a different operating system. This is somewhat comparable to the value of having negatives vs. photographs; you can do a lot more with the negatives, and the same is true for source code.

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An example of the utility of source code is seen in the source ports available at DoomWorld[23], which were made possible by the release of the Doom Engine to the public domain by id Software, as well as by the efforts of Doom

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enthusiasts who helped port the game to other operating systems. Because just the engine was released, players had to have a copy of the accompanying files in order to play the game, helping to preserve id's intellectual property rights. The game engine essentially acts as a driver or interpreter for the graphics, sound, and other individual objects that make up a complete game.

This discussion of objects other than binary files brings us to another important guideline laid out by InterPARES 2: identify all digital components. One of the challenges of preserving a videogame is that referring to it in the singular is deceptive. A videogame is actually made up of as many as hundreds of different objects, some of which may be hidden depending on the settings of the operating system one is using to access it. Making sure that every file is identified and every file-type known is an essential part of keeping an accurate record of the program. This is another area where having the source code is helpful. Identifying a file as a binary or executable is essentially useless; all information related to the structure and programming of the file is obscured. 23

Similar to InterPARES is the Variable Media Network's questionnaire for new media artists.[24] The questionnaire allows a curator to learn from the creator exactly what aspects of his or her work must be presented to allow for an accurate representation to be made in the future. It also helps to clarify any rights issues, and provides the rationale for recording the specific technologies used. Creating a similar questionnaire for videogame creators would give archivists and historians the ability to track the evolution of design platforms in addition to clarifying technical metadata and intellectual property concerns. 24

Beyond these two projects, some of the most useful things to come out of the archival world are standards for metadata and the Open Archival Information System (OAIS) reference model, which have obvious applications and import for any digital archive.[25] 25

Preservation through Adaptation

Having taken a preliminary look at how three different communities of practice approach the problem of video game preservation, we will now consider preservation strategies that involve reprogramming, reimplementation, re-creation, and adaptation. Our contention is that one of the preservation models that governs certain categories of virtual worlds, such as non-commercial IF, operates under the sign of modification rather than reproduction.[26] 26

Consider, for example, the case of *Mystery House*, the first graphical work of interactive fiction ever created. Released into the public domain in 1987, *Mystery House* was later reimplemented in the Inform programming language by the Mystery House Taken Over Occupation Force, comprised of Nick Montfort, Dan Shiovitz, and Emily Short [Montfort et al 2004]. While the reimplemented game hews closely to the original Apple II version, even going so far as to deliberately reproduce a programming error, it nonetheless also departs from its antecedent in interesting ways–sometimes intentionally (the original requirement to issue commands in upper-case text is pronounced "too dreary to bother reproducing," for example),[27] sometimes inadvertently and unavoidably (consistent with migration as a preservation strategy more broadly). Moreover, the game's commented code demonstrates how MHTO oscillates between a preservation project and a remix project: while the comments record a wealth of information about the original game, they also reflect a commitment to getting a younger generation of game enthusiasts interested in early IF by modding and remixing it. As a result, documentary and explanatory comments coexist with generative ones. Players learn about how the early graphics were coded, for instance, even as they are encouraged to substitute their own images for the crude line drawings that Ken and Roberta Williams originally included. Suggestions to remove a line or "rip out" a game behavior are interspersed throughout the source code, and a number of programming decisions have been made with player customization in mind. 27

It is clear that the MHTO Occupation Force, which commissioned ten contemporary digital artists to mod the game using a specially designed kit for the purpose, sees its reimplementation as an intermediary node in the genealogy of *Mystery House*, one that honors its predecessor and anticipates its successors; that is poised between *what was* and what *will be*. Nick Montfort's contribution, " *Mystery House* Kracked by the Flippy Disk," [28] pays homage to 1980s-era hackers who would make commercial games available for download on Bulletin Board Systems after breaking their 28

copy protection mechanisms. Montfort overlays the original *MH* graphics with fragments of Apple II crack screens, or the piratical equivalent of graffiti tags, that include the aliases of the crackers and shout-outs to fellow pirates. By ingesting such materials into the game itself, he inverts the customary relationship between text and context, transforming the game into an exhibition space for a particular class of vintage artifacts that help make first- and second-generation computer adventure games intelligible.

29 In its conceptualization and design, the MHTO project reflects a view of authenticity that Heather MacNeil, archives scholar, ascribes to Heidegger when she argues that cultural objects are "in a continuous state of becoming" [MacNeil and Mak 2007, 33]. According to this perspective, it is not stasis or fixity that serves as a guarantor of authenticity, particularly in the digital realm, but rather change and transformation; authenticity is "an anticipation, a process, and a continuous struggle" to become [MacNeil and Mak 2007, 29]. Paul Eggert neatly encapsulates the ineluctable truth that lies behind this model: "works do not stand still" [Eggert 2009, 13]. As MacNeil notes, while this particular formulation of authenticity is controversial in the field of archives and preservation where practitioners are dedicated to stabilizing cultural records, it has been fully naturalized over the last 15–20 years in the field of textual scholarship, a branch of literary studies concerned with the transmission of texts over time and which can be productively viewed as a sister discipline to archival science [MacNeil and Mak 2007, 33–38] [MacNeil 2005, 270]. If we plot these two differing views of authenticity along what Paul Eggert calls the "production-consumption spectrum of the life of the work," then it becomes evident that the principle of fixity, which privileges authorial agency, falls on the production end of the spectrum [Eggert 2009, 18]; and the principle of transformation, which privileges user agency, falls on the consumption end.[29] In one case, the authenticating function is invested in the author. In the other, it is the user.

30 It would be a mistake, however, to seize on the apparent oppositions. Where the two approaches converge is in their shared commitment to the continuity of the intellectual object; where they diverge is primarily a function of how much variance each is willing to tolerate in the different manifestations and expressions of the work. Moreover, the two value systems and the preservation strategies through which they are realized often work together rather than at cross-purposes. The player community not only reprograms and modifies classic games, it also develops emulators for them, allowing users to experience the games in an environment that mimics an obsolete platform or operating system and in a form that clones the structure and contents of the original software data files. For this reason the community may be said to be Janus-faced, looking forward to new incarnations of influential or obscure titles while at the same time looking backward to canonical versions and official releases. The availability of *Mystery House* as reverse-engineered source code written in a modern programming language *and* as a disk image of the original executable program (a byte-exact copy that can be run in an Apple II emulator) testifies to this basic duality — a duality that need not imply incompatibility.

Patterns of Interaction Across Communities

31 These inter-preservational approaches happen not only synchronically within a single community, but also diachronically across communities. The patterns of interaction often resemble those found in architectural preservation, where there is a clear reciprocity between residents of buildings, on the one hand, and preservationists, on the other. Writing about the functions and roles that each of these stakeholder groups assumes, Paul Eggert summarizes the resulting dynamic that unfolds in time: "only adaptive reuse [by generations of inhabitants] will have put very old buildings in a position to be proposed for professional conservation and curation in the present" [Eggert 2009, 22–23]. In the case of digital game preservation, an analogous relationship exists between user modification and institutional appraisal: players augment and extend the cultural relevance of computer games by modifying them for successive generations of users. These adaptations in turn increase the likelihood that professional archivists will eventually judge the games worthy of digital preservation.

32 A good example is *Colossal Cave Adventure*, created by Will Crowther c. 1975, which has the distinction of being the first documented computer text-adventure game. Inspired by Kentucky's Mammoth Cave system, the game inaugurated many of the conventions and player behaviors now associated with the genre, such as solving puzzles, collecting treasure, and interacting with the simulated fantasy world via short text commands [Jerz 2007, par. 1 and passim].[30] Originally written in FORTRAN, the code has been repeatedly ported and expanded by hackers, fans, and programmers over the years, most influentially by Don Woods (c. 1977), who, among other things, introduced a scoring system and

player inventory [Jerz 2007, pars. 10, 22, and 36]. The number of versions of *Adventure* is legion and continues to grow, with players mapping the evolution of the game using tree-like structures showing patterns of inheritance and variation. [31] In 2008, the Preserving Virtual Worlds project team selected *Adventure* as part of its archiving case set. After 34 years of continuous transformation under the stewardship of the user community, *Adventure* (in one or more of its protean forms) has now been ingested into an institutional repository, where it will undergo periodic integrity checks to ensure the inviolability of its bitstream over time. Professional preservation of *Adventure* will not supplant player preservation; rather, the two will co-exist. But it is fair to say that the intervention of the PVW team would not have happened in the absence of the transformational history that has kept *Adventure* alive for more than three decades.

33 Most of the game modifications referenced thus far are the product of what Alan Liu would call "smart constraints" [Liu 2006]: they are aesthetic, stylistic, and ludic in nature, encompassing changes to levels, characters, textures, descriptions, objects, and storylines. Generally speaking, they are creative hacks designed within the parameters of a given genre that are intended to enhance game play. By contrast, dumb constraints involve various concessions to technology; they are the unavoidable consequence of living in a material world where limited computer memory, storage, and bandwidth compromise — or at least modulate — artistic vision. While the distinction between smart and dumb constraints is by no means absolute, its utility lies in being able to generalize at a sufficiently high level about two variables affecting game mods.

34 Although primarily focused on the role of smart constraints in the development of *Adventure*, Dennis Jerz also pays attention to dumb constraints in his groundbreaking article on the game. He quotes M. Kraley, a former colleague of Crowther's, who recounts the first time his friend introduced him to *Adventure*: "[O]ne day, a few of us wandered into [Crowther's] office so he could show off his program. *It was very crude in many respects – Will was always parsimonious of memory* – but surprisingly sophisticated. We all had a blast playing it, offering suggestions, finding bugs, and so forth" (my emphasis) [Jerz 2007, par. 20]. Here, Kraley captures with a few swift strokes the long-standing tension between code size and program performance – a tension that would have been particularly pronounced in an era when computer memory was measured in kilobytes rather than gigabytes. By the time Crowther was modeling the "twisty little passages" of the Kentucky cave system in his text-based world, the principle of parsimony was already axiomatic. Steven Levy locates its origins in the mainframe computer culture of the 1950s and 60s, when "program bumming," or "the practice of taking a computer program and trying to cut off instructions without affecting the outcome," emerged as its own distinct aesthetic, cast in the crucible of limited physical memory and punchcard media, whose minimal storage capacity created a strong incentive for programmers to make their code as efficient as possible, thereby reducing the size of the program deck [Levy 1984, 26]. What began as a consequence of mundane technological circumstance quickly evolved into a competitive art form, and a hacker eager to prove his programming chops could do worse than find a bloated program to compress into fewer lines of code. "Some programs were bummed to the fewest lines so artfully," Levy notes, "that the author's peers would look at it and almost melt with awe" [Levy 1984, 44].

35 Parsimony is as much a gamer creed as it is a hacker creed. It is evident in the subculture of *speedruns*: recorded demos of players (or "runners") who complete a video game as quickly as possible by optimizing the play-through with no reversals, mistakes, or wasted effort.[32] Like code bums, speedruns represent a trend toward increasing efficiency, rationalization, and speed. They may not, however, involve the same degree of capitulation to dumb constraints, notwithstanding the clever exploitation of glitches in the game system to improve a run.[33]

36 The migration of parsimony from the code level to the game level is discernible in other ways as well. The concept implies not only efficiency, but also economy of expression, with a "less is more" ethos. It is this dimension of parsimony that game mods based on dumb constraints often reflect. One sees it, for example, in the readiness of an earlier generation of software pirates to sacrifice seemingly significant game properties in the interest of low-bandwidth "warez" distribution. The resulting game rips, which drained the digital objects of high-end features such as audio or video,[34] recall Kraley's association of parsimony with crudity. But crudity, as Matthew Kirschenbaum has observed, is a core tenet of hackerdom, not to be confused with lack of skill [Kirschenbaum 2008, 226–227]. It is consistent with a set of maxims in software design that fly under the banner of pragmatism and simplicity, boasting names such as "Worse is

Better"; "Keep It Simple, Stupid": and "The Principle of Good Enough." [35] Taken together, they imply a coherent approach to the problem of significant properties.

37 As part of the CAMiLEON emulation Project, Margaret Hedstrom and Christopher A. Lee have defined *significant properties* within the context of digital preservation as "those properties of digital objects that affect their quality, usability, rendering, and behaviour" [Hedstrom and Lee 2002, 218]. Similarly, the authors of the InSPECT report denote them as essential characteristics "that must be preserved over time in order to ensure the continued accessibility, usability, and meaning of the objects" [Wilson 2007, 8]. Despite the availability of these definitions, the InSPECT authors lament that "most of those who use the term would be hard-pressed to define it or say why it is important," [Wilson 2007, 6], adding "to date, little research has been undertaken on the practical application of the concept and approach. It is therefore widely recognized that there is a pressing need for practical research in this area, to develop a methodology, and begin identifying quantifiable sets of significant properties for specific classes of digital object[s]" [Wilson 2007, 7].

38 The convictions of the hacker community offer an interesting counterpoint to such ambivalence. The manifesto-like intensity with which hackers revere the principle of "all information should be free" [Levy 1984, 40], as well as its corollaries, the freedom to tinker and share, means that reproducibility functions as a kind of acid-test for significant properties. Outwardly, there is nothing particularly remarkable about this: the relationship between the sustainability of a creative object and the iterability of its constituent parts is widely recognized. The subject receives what is perhaps its fullest treatment in Nelson Goodman's *Languages of Art*, which remains one of the most formidable works on semiotics ever published. "The study of such engineering matters" that includes the "duplicability," "clarity," "legibility," "maneuverability," and "performability" of the individual units that comprise a notational system, is, Goodman states, "fascinating and [intellectually] profitable" [Goodman 1976, 154]. But while reproducibility is likely to inform any conversation about significant properties, it assumes pride of place in the context of software hacking. This is not to dispense with other criteria – one need only invoke the notorious failure of the Atari VCS port of *Pac-Man* in 1982 to realize that once a cultural artifact achieves iconic status, it becomes much harder to assess trade-offs between paying homage to the original and yielding to the technical exigencies of reimplementation on a different platform. But the siren call of adaptive reproduction frequently outweighs all other considerations. Indeed, a recurring theme "that runs throughout the history of the Atari VCS platform," according to Nick Montfort and Ian Bogost in *Racing the Beam*, is "the transformative port," especially of arcade games [Montfort and Bogost 2009a, 23]. In this context, what counts as "significant" is whatever the target platform can accommodate. Those properties that resist being shoehorned into the new system end up as collateral damage. In the case of the *Pac-Man* port, this included such venerable features as the paku-paku sound effects and the distinctive visual attributes of the ghosts, bonus fruits, and food pellets [Montfort and Bogost 2009a, 77–79]. The logic of adaptive reproduction, however, means that many properties that are casualties of an initial port can be re-integrated into subsequent ports. As Montfort and Bogost note, "later VCS *Pac-Man* hacks and rebuilds" re-introduced "credible arcade sounds, revised colors, better sprite graphics, and colored fruit." [Montfort and Bogost 2009a, 77]. Thus a relatively crude rendition of the game paved the way for more faithful renditions down the road. This ongoing process demonstrates how systems of semiotic relevance can be recalibrated over time in response to changing techno-cultural circumstances.[36]

39 Although a work of variable media art rather than a video game, the history of William Gibson's *Agrippa* illustrates another model of digital preservation that relies on asynchronous collaboration between different communities of practice, in this case hackers and scholars.[37] Like *Adventure*, the transmission and reception of *Agrippa* dramatizes the interaction between preservation-as-adaptation and preservation-as-reproduction, with the difference that dumb constraints play an even more decisive role in the fate of *Agrippa*. The crux of the challenge for hackers in 1992 was how to take a complex, auto-destructive, and cross-media work of art stored on a 3.5" floppy; copy it; and reformat it for online distribution prior to the era of the graphical web browser and at a time when ASCII was still the predominant currency of the internet. The crude hack they devised allowed *Agrippa* to survive as a text-only fragment on the network for sixteen years, creating the pre-conditions for its eventual emulation by Matthew Kirschenbaum, Doug Reside, and Alan Liu in late 2008.[38]

Agrippa was co-authored by the writer William Gibson and the artist Dennis Ashbaugh, and published by Kevin Begos, Jr. in 1992. Described in contemporary press releases as a “multi-unit artwork,” it is difficult to classify, both physically and generically [Gibson et al 1992, introduction]. It was originally sold in two versions: the deluxe version came wrapped in a shroud, its cover artificially aged and its pages scorched – “time-burned,” like the photo album described in Gibson’s poem, which functions as the central node of the work. Inside are etchings by Ashbaugh and double columns of DNA that ostensibly encode the genome of a fruitfly [Kirschenbaum 2008, xi]. Nestled in the center of the book is a 3 ½ inch floppy disk that contains a poem by Gibson, a meditation on time, memory, and decay. Its governing metaphor is that of the *mechanism* “a trope,” notes Matthew Kirschenbaum, “that manifests itself as a photograph album, a Kodak camera, a pistol, and a traffic light, as well as in less literal configurations” [Kirschenbaum 2008, ix]. *Agrippa*, among other things, is about our misplaced faith in the permanence and objectivity of media. Like human memories, media distort, invent, and erase the very objects they’re designed to preserve: handwriting fades and becomes illegible, photographs break the fourth wall by constantly reminding us of the world that lies just outside the picture frame, and inert technological artifacts put up no resistance when new ones come along to replace or destroy them. Paradoxically, the speaker of the poem takes recourse in his own recollections to supplement the incomplete records of the past, records that were originally intended to compensate for the limitations of memory. By such a process, he tries to recapture, for instance, the smells of the saw-mill once owned by his father, whose “tumbled boards and offcuts” are pictured in an old photograph [Gibson et al 1992]. Drawing on a synaesthetic imagination, he uses the visual stimulus to prompt an olfactory memory. This complex interplay between mechanism and memory structures the poem as a whole and shapes its manifold meanings. 40

Agrippa’s core themes are expressed through form as well as content: some of Ashbaugh’s etchings are overlaid with images printed in uncured toner, which are inevitably smudged and distort those beneath and facing them when the pages are turned [Kirschenbaum 2008, xi]. More stunningly, as has been often described, Gibson’s electronic poem is encrypted to scroll automatically down the screen once before being irrevocably lost, its text disappearing after a single reading. *Agrippa* is therefore subjected, like all material objects, to the forces of decay, but here those forces are manufactured rather than natural, causing the work to disintegrate at an accelerated rate. Ashbaugh, in particular, took considerable delight in anticipating how this volatility would confound librarians, archivists, and conservators: as Gavin Edwards explains, to register the book's copyright, Ashbaugh “would need to send two copies to the Library of Congress. To classify it, they . . . [would] have to read it, and to read it, they . . . [would have to] destroy it.” [Edwards 1992]. Significantly, however, it was not the librarians who found a workaround to the problem, but the pirates. On December 9, 1992, a group of New York University students, including one using the pseudonym of “Rosehammer” and another that of “Templar”, secretly video-recorded a live public performance of *Agrippa* at The Americas Society, an art gallery and experimental performance space in New York City. After transcribing the poem, they uploaded it as a plain ASCII text to MindVox, a notorious NYC Bulletin Board, “the Hells Angels of Cyberspace,” according to Wikipedia, where it was readily available for download and quickly proliferated across the web. 41

“The Hack,” as the incident has come to be called, is told with the hard-boiled suspense of a detective story by Matthew Kirschenbaum, who uncovered the details while working on his award-winning book *Mechanisms: New Media and the Forensic Imagination*. For Kirschenbaum, the creation of the surreptitious recording marked a fork in the road for the NYU students: “What,” he asks, “were Rosehammer and Templar to *do* with their bootleg video” [my emphasis] [Kirschenbaum et al 2008]. 42

> In 1992, of course, uploading the actual footage to the Internet would have been impossible to contemplate from the standpoint of storage and bandwidth (let alone with available means of playback). Therefore, just the text of Gibson’s poem was manually transcribed and posted to the MindVox BBS as a plain-text ASCII file, which allowed it to propagate rapidly across bulletin boards, listservs, newsgroups, and FTP sites. Today, however, the footage would have undoubtedly been posted direct to YouTube, Google Video . . . or some other streaming media site, eliminating the need for scribal mediation. It is worth remarking, then, that the brilliant act of low-tech, manual, and analog transcription through which Rosehammer and Templar accomplished their “hack” of *Agrippa* (analog video copied by hand as text) ineluctably dates *Agrippa* as the product of a certain

technological moment at the cusp between old and new media [Kirschenbaum et al 2008].

In the final analysis, network throughput served as the arbiter of significant properties, forcing the hackers to attempt to distill *Agrippa* down to its essence: a static 305-line "semi-autobiographical" poem. If this austere version seems wholly incapable of functioning as a proper surrogate for the original, then it's worth underscoring the role it played in bringing about the revival of *Agrippa* through high-fidelity emulation of the software program. Reflecting on the web-based "Agrippa Files" archive where the disk image of the program now lives, Kirschenbaum explains its significance: 43

> These materials . . . offer a kind of closure to anyone who, like me, has ever stumbled across the text of *Agrippa* on the open net and wondered, but how did it get there? Those mechanisms are now known and documented. So we take satisfaction in the release of these new "Agrippa files" (as it were) to scholars and fans alike, and we marvel that after sixteen years in the digital wild a frail trellis of electromagnetic code once designed to disappear continues to persist and to perform. [Kirschenbaum et al 2008]

The example of *Agrippa* reminds us that preservation sometimes courts moderate (and even extreme) loss as a hedge against total extinctive loss. It also indirectly shows us the importance of distributing the burden of preservation among the past, present, and future, with posterity enlisted as a preservation partner. However weak the information signal we send down the conductor of history, it may one day be amplified by a later age. 44

Recommendations

[39] 45

There is a need for memory institutions interested in establishing video game repositories to support policy positions and offer services that are better aligned with the preservation and use practices of the game community, not only because of the potential for integrating the members of this community into the larger preservation network, but also because their attitudes and values may well influence those of professional archivists in years to come. With their deep curatorial investment in games, players have adopted a versatile set of approaches for collecting, managing, and providing long-term access to these cultural artifacts. While bitstream preservation and emulation are an essential part of the overall picture to which gamers have made enormous contributions, so too are re-releases, remakes, demakes, ports, mods, and ROM hacks.[40] As a result, game archives in the wild often reflect notions of authenticity that are different from those of memory institutions.[41] While the dominant orientation of archivists is toward the stabilizing of cultural records, gamers can tolerate, and indeed embrace, greater variability in the objects with which they interact.[42] The Mario Brothers franchise, for example, has persevered largely because of the consumer appetite for new and altered game levels, powerups, graphics, characters, and items. The "softer" view of authenticity that underlies these strategies operates at what Seamus Ross would call a "lower threshold of verisimilitude" [Ross 2010].

What policy initiatives and preservation services might be adopted in response to the needs, practices, and perspectives of players and player-archivists? We propose the following: 46

Digital Preservation Services: Comparative Methods and Stemmatics

In addition to providing authenticated capture, ingest, hashing, and storage services for archival copies of games, digital repositories might also offer appropriate services for access copies of games in the wild. Because these copies are often modified rather than fixed representations and in line with the "softer" canons of authenticity previously mentioned, repositories could provide users and player-archivists with the means to analyze, document, and measure their inter-relationships using similarity metrics and other approaches. 47

Applying the techniques of digital stemmatics, archivists could help users visualize and interpret these patterns in sophisticated ways. Developed in the 19th Century, stemmatics codified a set of methods for analyzing the filiation of literary manuscripts. Significantly, the tree structures representing these relationships have parallel importance in evolutionary biology and historical linguistics, where they are used to group genomes or languages into families; show 48

how they relate to one another in genealogical terms; and reconstruct lost archetypes [Kraus 2009]. Speculating on the role of digital stemmatics (or phylogenetics, as the comparative method is called in biology) in the context of personal digital archives, Jeremy John of the British Library has postulated that "future researchers will be able to create phylogenetic networks or trees from extant personal digital archives, and to determine the likely composition of ancestral personal archives and the ancestral state of the personal digital objects themselves" [John et al. 2010, 134].

Stemmatic methods have already been applied to board games: Joseph Needham, a pioneering historian of East Asian science, technology, and culture, published a family tree of board games connecting divination, liubo, and chess through a long line of ancestry and descent [Needham 1962, 331]; and biologist Alex Kraaijeveld has applied phylogenetics to variants of chess to help determine its place of origin [Kraaijeveld 2000, 39–50]. The methodology therefore shows great promise for the study of video and computer games in the wild, where variability rather than fixity of representation is often the norm. 49

Two other tools cited recently by Jeremy John are also relevant in this context: 50

> **ccHost** – an open-source content management system developed under the auspices of Creative Commons that can be used to track and document how media content is used, reused, and transformed on the web. (ccMixter, the popular music site for remixing and sharing audio samples, is powered by ccHost.) [43]
>
> **Comparator** – a tool developed by Planets (Preservation and Long-term Access through Networked Services), a four-year project funded in part by the European Union. Comparator is designed to measure degrees of similarity between different versions of a digital object.[44]

Digital Preservation Services: Calculating Trust in Fan-Run Game Repositories

Because game archives in the wild cannot usually be authenticated according to standard integrity checks, an alternative method for evaluating the authenticity of their holdings might involve the application of trust-based information. Jennifer Golbeck, for example, has demonstrated how the trust relationships expressed in web-based social networks can be calculated and used to develop end-user services, such as film recommendations and email filtering [Golbeck 2005]. Applying Golbeck's insights, archivists could leverage the trust values in online game communities as the basis for judgments about the authority or utility of relevant user-run repositories, such as abandonware sites and game catalogs. Under this scenario, authenticity is a function of community trust in the content being provided. One consequence of this approach is that authenticity and mutability need not be considered mutually exclusive terms; on the contrary, fan-run game repositories that make provisions for transformational use of game assets — such as altering the appearance of avatars or inventory items — might in many instances increase trust ratings. 51

Coda

In her book *Reality is Broken: Why Games Make Us Better and How They Can Change the World*, veteran game designer Jane McGonigal argues that far from "jeopardizing our future," as author Mark Bauerlein would have it [Bauerlein 2009], video and massively multiplayer online games have the potential to help us solve some of the world's most pressing challenges, from energy crises to climate change to global hunger. "Game design isn't just technological craft," she says, "it's a twenty-first-century way" of collaborating, thinking, problem-solving, and changing attitudes and behavior [McGonigal 2011, 13]. As a proof of concept, McGonigal has spent the last several years developing and implementing a number of highly influential Alternate Reality Games – including *World Without Oil*, , and *Evoke* – whose collective purpose is to arrive at "creative solutions to our most urgent social problems" "through planetary-scale collaboration" [45]. Although the games have spawned a gripping counterfactual record of convincing antidotes to and scenarios of near-future epidemics and calamities, "none of them," McGonigal has remarked, in referring to the entire universe of MMO and video games, not just her own, "have saved the real world yet." [McGonigal 2010] 52

Or *have* they? 53

Vincent Joguin, an expert in computer emulation, was an avid gamer and demoscene programmer in the 1990s, producing so-called “intros” to cracked games, organizing demoscene parties, and later helping to develop a number of widely used emulators for classic home computer and console systems, including the Atari ST.[46] In 2009, Joguin and his collaborators secured external funding for an ambitious project to create emulation-based preservation services and technologies in partnership with a number of renowned European institutions and the already extant PLANETS initiative.[47] One component of the system is Dioscuri, an emulator that is modular in design: “modularity” in this context means that a range of standard hardware components have each been individually emulated, creating a collection of mini-emulators that in theory can be combined and extended in myriad ways to mimic almost any imaginable computer architecture. Joguin’s signature contribution, however, is a virtual computer small and simple enough to be continuously ported to new platforms. One virtue of Olonys, as the system is called, is that it in effect liberates emulators such as Dioscuri from hardware-specific environments, allowing them to execute on any computer. It thus addresses one of the great paradoxes of preservation through emulation: the need to create meta-emulators to run already existing emulators, whose host systems will themselves expire in time.[48] 54

In its broad strokes, the trajectory of Joguin’s career – from video game enthusiast to programmer hobbyist to dedicated digital preservationist – is recapitulated in the trajectories of countless numbers of players, who over the last two decades or more have been modeling community-driven practices and solutions to collecting, documenting, accessing, and rendering video games, arguably the most culturally resonant digital artifacts of our time. As we have seen, there is no shortage of preservation challenges with which to contend: bit rot, the scourge of technological obsolescence; the parasitic reliance of software programs on code libraries supplied by the operating system and other software packages; and the growing number of digital collections sitting on “shifting foundations of silicon, rust, and plastic” as one writer has ominously expressed it [Bergeron 2002]. Complex interactive computer games represent the *limit case* of what we can do with digital preservation. If we can figure out how to keep a classic first-person shooter alive, we’ll have a better idea of how to preserve computational simulations of genetic evolution, climate change, or the galactic behavior of star systems. Just as importantly, we’ll also have the technical and social knowledge to maintain the billions of quotidian electronic records — emails, memos, still images, sound files, videos, e-books, instant messages — that constitute the collective memory of our civilization. 55

To speak of the contribution of gamers exclusively in the future tense, however, is to fail to do justice to the scope and ingenuity of their accomplishments thus far, as demonstrated in this paper. “The internet is populated with legions of amateur digital archivists, archaeologists, and resurrectionists,” wrote Stewart Brand of the Long Now Foundation more than a decade ago [Brand 1999, 91]. He went on to elaborate: 56

> They track down the original code for lost treasures such as *Space Invaders* (1978), *Pac-Man* (1980), and *Frogger* (1981), and they collaborate on devising emulation software that lets the primordial programs play on contemporary machines. *The . . . techniques pioneered by such vernacular programmers are at present the most promising path to a long-term platform migration solution . . . such massively distributed research can convene enormous power.* (emphasis added) [Brand 1999, 91].

It is no accident that this tribute to the heroic efforts of the player community comes at the conclusion of a chapter entitled “Ending the Digital Dark Ages.” For Brand, video games serve as a skeleton key for unlocking the complexities of digital preservation, empowering us to prevent an epochal “digital black hole.” The import of his message is clear: for love of space invaders and bonus fruits, of rescuing the girl and fighting and defeating the boss; for love of treasure, power-ups, and sprites; for love of all these things, players have been inspired to save our video game inheritance. But in the process of salvaging these fragile 8-bit worlds, they have also helped save some of the real world. Like the technology trees found in popular strategy games, where the acquisition of one technology is dependent on that of another, the solution to any of the superthreats conjured by McGonigal, from pandemics to fuel shortages to mass exile, is predicated on methods for reliably transmitting legacies of knowledge from one generation to the next. When those legacies are encoded as bitstreams, it is video game players who have been in the vanguard of figuring out how to do it, bolstering McGonigal’s assertion that gamers are a precious “human resource that we can use to do ‘real-world’ work ” 57

[McGonigal 2010].

“Games can save the world,” Jane McGonigal emphatically tells us.

58

Jane, they already have.

59

Notes

[1] Early versions of portions of this paper were delivered by Kari Kraus, Rachel Donahue, and Megan Winget, “Game Change: The Role of Amateur and Professional Cultures in Preserving Virtual Worlds” Conference paper. Digital Humanities Conference, College Park, MD (June 22-29 2009); and Rachel Donahue, “ ‘Do You Want to Save Your Progress?’ Preservation Strategies of the Game Industry, and What Their Users Could Teach Them,” Society of American Archivists Annual Meeting, August 2009.

[1] “Preserving Virtual Worlds,” Preserving Creative America initiative under the National Digital Information Infrastructure Preservation Program (NDIIPP) administered by the Library of Congress. Project partners include the University of Illinois at Urbana- Champaign (lead, under direction of Jerome McDonough), the University of Maryland, Stanford University, Rochester Institute of Technology, and Linden Lab. January 2008 - December 2009.

[2] For a copy of Donahue’s survey questions, see the Appendix to the Game Preservation Special Interest Group White Paper, *Before It’s Too Late* (2009), authored by Henry Lowood, Andrew Armstrong, Devin Monnens, Zach Vowell, Judd Ruggill, Ken McAllister, and Rachel Donahue. Available for download at http://wiki.igda.org/Game_Preservation_SIG/White_Paper/Before_It%27s_Too_Late:_A_Digital_Game_Preservation_White_Paper.

[3] Compare, for example, the diametric perspectives of Clay Shirky, *Here Comes Everybody: The Power of Organizing Without Organizations* (Reprint. New York: Penguin, 2009) and Andrew Keen, *The Cult of the Amateur: How Today's Internet is Killing Our Culture* (New York: Doubleday, 2007).

[4] See [Depocas et al 2003]; Random Clod [i.e., Randall McLeod], “Information on Information,” *Text* 5 (1991): 270; Paul Eggert, *Securing the Past* (Cambridge: Cambridge UP, 2009) 22–23. Marc Ruppel has discussed the concept of “permanence through change” in the context of transmedia narratives. See Ruppel, *Narrative Convergence, Cross-Sited Productions, and the Archival Dilemma*. *Convergence* 15 (2009): 281–298.

[5] See, for example, [Cox 2009, 2–3, 192–200] .

[6] This view of authenticity is described and historicized in [MacNeil and Mak 2007] (see also [MacNeil 2005]) in *Cultural Artifacts and the Production of Meaning*, ed. Margaret J. M. Ezell and Katherine O'Brien O'Keeffe (Ann Arbor: U of Michigan P, 1994) 85–99.

[7] The terminology of “data-centric” and “process-centric” approaches to digital preservation is taken from [Wilson 2007, 3].

[8] W. Crowther and D. Woods, “Adventure”. [aka “ADVENT”> and “Colossal Cave”] FORTRAN source code (1977) http://mirror.ifarchive.org/if-archive/games/source/adv350-pdp10.tar.gz.

[9] A quantitative study of the scarcity of videogames was conducted in the UK in 2008. The study took a sample of videogame consoles, as well as 50 video game cartridges for the Atari 2600, and examined their availability in archives, on internet sale sites, and as illegal ROMs for download and play on emulators. The study determined that pirated ROMs present the most available resource for games, and that all of the archives found to contain the selected games were located in the United States. The recent opening of the UK National Videogame Archive may change this dispersal problem, but the rarity of authentic, original game copies represents a challenge to those who seek to preserve them. Paul Gooding and Melissa Terras, “Grand Theft Archive: A Quantitative Analysis of the State of Computer Game Preservation,” *International Journal of Digital Curation* 3 (2008): http://www.ijdc.net/index.php/ijdc/article/view/85.

[10] In this paper we propose alternate conceptions of “authenticity” for video games that may align better with their complex version histories. See the “Preservation Through Adaptation” and “Patterns of Interaction Across Communities” sections, as well as “Recommendations.”

[11] For a discussion of intellectual property rights as they relate to the economic value chain of the video game industry, see James Conley, et al., “Use of a Game Over: Emulation and the Video Game Industry,” *Northwestern Journal of Technology and Intellectual Property* 2 (2004): http://www.law.northwestern.edu/journals/njtip/v2/n2/3/. For an opposing viewpoint — that hacking and piracy benefit society — see Will Jordan, “From Rule-Breaking to ROM-Hacking: Theorizing the Computer Game-as-Commodity,” *Situated Play*: Proceedings of DiGRA 2007 Conference

(2007): 708–713. For a discussion of what archivists and librarians can learn from video game players about IP reform, see Kari Kraus, " 'A Counter-Friction to the Machine': What Game Scholars, Librarians, and Archivists Can Learn from Machinimists about User Activism." *Journal of Visual Culture* (special Machinima-themed issue guest-edited by the Stanford Humanities Lab) 10 (2011): 100–112.

[12] For a detailed example of the essential characteristics of videogames, and a preservation model using PLANETS, see M. Guttenbrunner, C. Becker, and A. Rauber, "Evaluating Strategies for the Preservation of Console Video Games," *Proceedings of the Fifth international Conference on Preservation of Digital Objects* (iPRES 2008), London, UK, September 29–30, 2008 http://www.ifs.tuwien.ac.at/~guttenbr/pubs/guttenbrunner_ipres2008.pdf. The IMLS-funded project directed by Jerry McDonough, "Preserving Virtual Worlds II: Methods for Evaluating and Preserving Significant Properties of Educational Games and Complex Interactive Environments," with which Kraus and Donahue are both involved, aims to address related issues.

[13] As an example, Sierra's *Mystery House* was not just a first for the company — it was the first text adventure to incorporate graphics. An amazing breakthrough at the time, it seems crude in comparison to today's realistic 3D environments.

[14] http://www.atariage.com/forums/index.php?showforum=75

[15] "Configuration Management," *Wikipedia*. http://en.wikipedia.org/wiki/Configuration_management.

[16] http://c64-longplays.de/

[17] http://www.amigaforever.com/

[18] A ROM is a digital file that clones all the contents of a given read-only storage medium, such as a game cartridge, right down to the slack space at the end of a file.

[19] http://www.gamesetwatch.com/2009/04/mike_tysons_intergalactic_powe.php

[20] http://www.geocities.com/TimesSquare/Lair/9260/ewok.html

[21] Richard Pearce-Moses, InterPARES, SAA: Glossary of Archival Terminology http://archivists.org/glossary/term_details.asp?DefinitionKey=1794.

[22] InterPARES 2 Project, directed by Luciana Duranti: http://www.interpares.org/ip2/ip2_index.cfm.

[23] DoomWorld is a community-run portal for all things related to all versions of the DOOM video game, developed and released by id software. This includes history, downloads, help files, forums, news, feature articles, and a myriad of topical sites hosted by the portal for other DOOM enthusiasts. http://www.doomworld.com/

[24] Alain Depocas, et al, *Permanence Through Change,* http://variablemedia.net/e/preserving/html/var_pub_index.html; Variable Media Questionnaire, a Forging the Future Project, co-designed by John Bell and Jon Ippolito http://variablemediaquestionnaire.net/

[25] http://public.ccsds.org/publications/archive/650x0b1.pdf

[26] More precisely, adaptation exists alongside reproduction as a preservation strategy; the two often work in tandem.

[27] To view the source code, download the Mystery House Taken Over Occupation Kit at http://www.turbulence.org/mhto_kit.tgz

[28] Available for download on the MHTO Games page at http://www.turbulence.org/Works/mystery/games.php

[29] While we are accustomed to classifying the output of cultural consumption as secondary source material (for example, marginalia or critical commentary in the case of novel reading; machinima or recams in the case of game play), it can also take a form that more closely resembles primary source material: should the various expansions and ports of Will Crowther's Colossal Cave *Adventure* be interpreted as context for the original game or as legitimate repetitions of it, albeit with modifications? The question is intended to challenge the dichotomy that *seems* to inhere in Eggert's model: namely, that production and consumption are two entirely distinct activities. The theory of co-creation integral to a Heideggerean view of authenticity suggests that eventually the two ends of the spectrum become mirror images of each other.

[30] We have relied on Jerz's brilliantly researched essay for an understanding of the history and vicissitudes of *Adventure*.

[31] Russel Dalenberg, *Adventure* Family Tree," Russel Dalenberg's Home Page [personal web site], 2004

http://www.io.com/~ged/www/family.html; Dalenberg, “Versions and Ports of *Adventure* known to exist” v.2.6.7 Russel Dalenberg’s Home Page [personal web site], 2006 http://www.io.com/~ged/www/advelist.html.

[32] Wikipedia, “Speedrun” http://en.wikipedia.org/wiki/Speedrun; Henry Lowood, “High-Performance Play: The Making of Machinima,” in *Videogames and Art: Intersections and Interactions*, ed. Andy Clarke and Grethe Mitchell (London: Intellect Books; Chicago: Univ. of Chicago Press, 2007): 59–79. Earlier draft available online at www.stanford.edu/~lowood/.../highperformanceplay_finaldraft.pdf.

[33] For a classic account of exploiting bugs and glitches in id Software’s first-person shooter *Quake* to improve a speedrun, see Anthony Bailey’s “ZigZagging through a Strange Universe,” originally published on *Planet Quake* (12 October 1997), now available at http://speeddemosarchive.com/quake/qdq/articles/ZigZag/

[34] Indhu Rajagopal and Nis Bojin, “Cons in the Panopticon: Anti–Globalization and Cyber–Piracy,” *First Monday* 9 (2004): http://firstmonday.org/htbin/cgiwrap/bin/ojs/index.php/fm/article/view/1174/1094. For further context, we quote Rajagopal and Bojin’s discussion of so-called “game rips” in full: “Pirated programs known as ‘rips,’ i.e., programs that have had superfluous items extracted from it, designed largely for the bandwidth–impaired . . . are available for file sharers and warez Web sites. For instance, where a full digital ISO image of a game may be as much as 700 MB in size, a rip of that game can be far less, once the music and videos from the game have either been removed or large textures in the game have been downsampled, i.e., reduced in quality from the original. This can result in a 700 MB file becoming a 70 MB game, which is much more accessible to those who wish to offer it with their own server space and for downloads on a low–bandwidth connection. A similar technique is applied to applications, movies whose underlying premise is of the ‘lossy’ MP3 format, which has acted as a cornerstone file type, elevating audio piracy to its current state of popularity . . . Game rip releasers often even go the distance, allowing users to customize their game if they have the bandwidth. A stripped down version of the game will often be released with its removed components also made available for download, if desired. Thus, one could download a copy of a sports game, the music for the game, the movies for the game and in–game commentary, all separately. This practice is predominant among newsgroups.” See also Solveig Singleton, “Copy Protection and Games: Lessons for DRM Debates and Development,” Progress and Freedom Foundation [a conservative think-tank based in Washington D. C.] (2007): 3 http://www.pff.org/issues-pubs/pops/pop14.2gamecopyprotectDRM.pdf.

[35] Wikipedia “Unix Philosophy,” http://en.wikipedia.org/wiki/Unix_philosophy#Worse_is_better; Wikipedia “Worse is Better,” http://en.wikipedia.org/wiki/Worse_is_better

[36] Of course the logic of adaptive reproduction can also result in tricked-out, augmented, or enhanced audio-visual capabilities in a given game franchise that take full advantage of upgrades in sound and video card technology and increased processing power over time. For a discussion of the role of “techno-historic” constraints on game aesthetics, see Andrew Hutchison, “Making the Water Move: Techno-Historic Limits in the Game Aesthetics of *Myst* and *Doom*,” *Game Studies* 8 (2008): http://gamestudies.org/0801/articles/hutch.

[37] The vagaries of the poem and its associated media artifacts are documented in several sources: The *Agrippa* Files, Transcriptions Project, University of California Santa Barbara, http://agrippa.english.ucsb.edu/; Matthew Kirschenbaum, Doug Reside, and Alan Liu, “No Round Trip: Two New Primary Sources for *Agrippa*,” http://agrippa.english.ucsb.edu/kirschenbaum-matthew-g-with-doug-reside-and-alan-liu-no-round-trip-two-new-primary-sources-for-agrippa; and Kirschenbaum, *Mechanisms* Introduction, Chpt. 5 (“Text Messaging: the Transformissions of *Agrippa’* ”) and the Appendix.

[38] See [Wilson 2007, 6].

[39] The “Recommendations” section of this paper reproduces, with a few modifications, portions of the “Intellectual Property and Digital Preservation: Widening the Discussion” section of the Preserving Virtual Worlds Final Report, which Kraus and Donahue collaborated on with other members of the PVW team. The report was issued as a white paper to the Library of Congress' National Digital Information Infrastructure for Preservation Program. Co-authored with Jerome McDonough (first author; all other authors grouped by institution), Robert Oldendorf (University of Illinois Urbana-Champaign); Matthew Kirschenbaum, Kari Kraus, Doug Reside, Rachel Donahue (University of Maryland); Andrew Phelps and Christopher Egert (Rochester Institute of Technology); Henry Lowood and Susan Rojo (Stanford University). September 2011 http://hdl.handle.net/2142/17097

[40] “Remake” and “demake” are game design terms coined by Ian Bogost. As defined by Bogost, remakes “are recreations of earlier works, irrespective of the hardware platform of original creation or recreation.” Conversely, demakes are “retro-inspired reimaginings of modern games, as if they had been created on earlier hardware. Demakes are not necessarily created to run on older machines, but their design and behavior are constrained by the real or perceived constraints of vintage systems.” See Bogost’s spring 2010 syllabus for “Atari Hacks, Remakes and Demakes: Special Topics in Game Design and Analysis,” available at http://www.bogost.com/teaching/atari_hacks_remakes_and_demake.shtml.

[41] "Archives in the wild" is a phrase coined by Jeremy John, et al. in the British Library's *Digital Lives / Personal Digital Archives for the 21st Century: An Initial Synthesis* (3 March 2010) Beta Version 0.2 http://britishlibrary.typepad.co.uk/files/digital-lives-synthesis02-1.pdf.

[42] A notable exception to this argument, however, is the Software Preservation Society, founded in 2001 by videogame enthusiasts. SPS, whose mission is to preserve original game releases, has issued several diatribes against hacked, cracked, pirated, and otherwise altered versions of games. See The Software Preservation Society, "The Importance of Digital Preservation" http://www.softpres.org/article:importance_of_digital_preservation.

[43] Information about ccHost and ccMixter can be found online at http://wiki.creativecommons.org/CcHost and http://ccmixter.org/. See also [John et al. 2010, 56] [John et al. 2010, 156n244].

[44] For more on PLANETS, see http://www.planets-project.eu/about/

[45] Urgent Evoke: "About the Evoke Game," 27 January 2010, posted by Alchemy http://blog.urgentevoke.net/2010/01/27/about-the-evoke-game/; Jane McGonigal, "Biography" http://www.avantgame.com/bio.htm.

[46] Vincent Joguin "Home Page" http://vincent.joguin.com/; Joguin, "Keep — Major European Research Project on Emulation," Game_Preservation listserv, 7 February 2009 http://six.pairlist.net/pipermail/game_preservation/2009-February/000859.html; "Meet KEEP People at the Assembly," KEEP website 22 July 2009 http://www.keep-project.eu/ezpub2/index.php?/eng/About-KEEP/News/Meet-KEEP-people-at-the-Assembly; ARTtech Seminar Speakers, "Vincent Joguin", Summer 2009 http://www.assembly.org/summer09/seminars/speakers; Joguin, conversation with the author (Kraus) 5 July 2010, at the Digital Lives Research Seminar, "Authenticity, Forensics, Materiality, Virtuality and Emulation: Advances in the Curatorship and Scholarship of Personal Digital Archives", Personal Digital Manuscripts Project at the British Library http://britishlibrary.typepad.co.uk/digital_lives/2010/07/index.html

[47] Keep Project (Keeping Emulation Environments Portable), funded by the European Union's Seventh Framework Programme for Research and Technological Development (FP7), 2009 http://www.keep-project.eu/ezpub2/index.php

[48] For more on Dioscuri and Olonys within the context of the KEEP project, see KEEP, "Beyond the State of the Art," http://www.keepproject.eu/ezpub2/index.php?/eng/About-KEEP/Technical-solution/Progress-beyond-the-state-of-the-art.

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