# Before It's Too Late
## A Digital Game Preservation White Paper

•

Henry Lowood (editor)

and

Devin Monnens, Zach Vowell, Judd Ethan Ruggill,
Ken S. McAllister, Andrew Armstrong (authors)

Over the last four decades, electronic games have profoundly changed the way people play, learn, and connect with each other. Despite the tremendous impact of electronic games, however, until recently, relatively few programs existed to preserve them for future generations of players and researchers. Recognizing the need to save the original content and intellectual property of electronic games from media rot, obsolescence, and loss, the Game Preservation Special Interest Group of the International Game Developers Association has issued a white paper summarizing why electronic games should be preserved, problems that must be solved to do so, some potential solutions, and why all these issues should matter to everyone interested in electronic games and play in general. In the white paper, the editing of which was partially supported by the Preserving Virtual Worlds project and by funds from the Library of Congress, its editor and six authors (Rachel Donahue created a survey for IGDA members not included in this article) issue a call for heightened awareness of the need to preserve electronic games—endangered by relatively rapid electronic decay and intellectual neglect alike—for play scholarship and for the culture of the twenty-first century.

## Henry Lowood: Introduction

THE GAME PRESERVATION SPECIAL INTEREST GROUP (SIG) of the International Game Developers Association (IGDA) was founded in 2004, only five years ago. Even in this short time, however, interest in the preservation of digital games and virtual worlds has intensified remarkably. Today, cultural institutions such as universities, libraries, and museums have begun to collect, display, and make available artifacts of game culture, and opportunities for the practical and

critical study of game content and technology are increasing rapidly. Game studies, a field that barely existed ten years ago, now boasts of annual conferences, journals, and organizations dedicated to it.

All of these developments are fine and good. In this white paper, however, members of IGDA address a threat not just to academic game studies and the historical appreciation of game culture, but also to game developers and the industry itself: the potential disappearance of original game content and intellectual property through media decay, obsolescence, and loss.

We wish to be very clear about one point. So at the risk of repetition, allow us to say it again in other words: if we fail to address the problems of game preservation, the digital games of today will disappear, perhaps within a few decades. We will lose access to the history and culture of contemporary games and find it impossible to trace the influence of interactive digital games and simulations on other forms of play, leisure, entertainment, communication, learning, and work.

The publication of this white paper in the *American Journal of Play*, therefore, is primarily aimed at a readership of game and play researchers and scholars. Our intention is to present the problems that we face with electronic games before it is too late. We want to raise red flags about the issue and grab the attention of the *Journal*'s readership. Our next step will be the preparation and distribution of a second white paper on best practices and solutions at the Game Developer Conference (GDC) in 2010. Meanwhile, please consider joining the IGDA Game Preservation SIG and helping us in our work.

## Devin Monnens:
## Losing Digital Game History, Bit by Bit

Digital games are in dire need of preservation. Every year, thousands of games move one step closer to oblivion as a result of the same threats to longevity that affect all digital media: bit rot and obsolescence. Digital media have a shockingly short life-span due to the natural decay of the original materials and the rapid obsolescence of older media forms, as well as the failure and obsolescence of the hardware necessary to run them. Many digital games that are only a few decades old are already at risk and require immediate preservation attention. Libraries and archives around the world have only just begun to pay serious attention to digital games, yet they already face the immediate problem of trying to work

together. If no concerted action is taken to save these games before they disappear forever, we will have lost the foundation of the industry's history. It will not be enough simply to hand the problem over to libraries and archives that are beginning to collect digital games—these repositories lack the expertise and funding to solve the many problems of digital preservation. They will also need the industry to help, because preservation methods are further complicated through current business practices of digital rights and distribution. In short, thousands of digital games are on their last life. Once they reach that final Game Over screen, we will not get a replay.

### Media Decay or Bit Rot

The greatest threat to the longevity of digital games is media decay, also known as *bit rot*. Bit rot is the gradual and natural decay of digital information and storage media over time, causing information to become unreadable. Bit rot affects different storage formats at different rates. Magnetic storage and optical discs are especially susceptible to varying forms of digital decay. For the time being, masked read-only memory (ROM) cartridges appear to be fairly durable, while EPROMs (Erasable Programmable ROMs) are at greater risk.

### Magnetic Disks

Magnetic storage media such as floppy disks, magnetic tape, and hard drives are particularly susceptible to bit rot. In magnetic storage, media decay results from the weakening of the disk's magnetic properties over time, causing them to fade and become unreadable.[1] Floppy disks are at the greatest risk of decay due to the flimsy material of these disks and their age, which in many cases now exceeds their life expectancy. Games stored on magnetic tape are also at risk. Current estimates place the life-span of floppy disks at between ten and thirty years.[2] Disks created before 1985 already show considerable signs of decay.[3]

Thousands of games were published on 3.5-inch and 5.25-inch floppy disks prior to the mid-1990s. Many of these disks are now over twenty years old and well on their way to oblivion. It is, therefore, critical that preservation methods be undertaken to preserve games stored on magnetic media before the large and significant part of the history they carry is lost forever.

### Optical Discs

Optical discs can be damaged physically by pits and surface scratches as well as chemical deterioration due to inks, adhesives, and other materials, but they

are also affected by bit rot. The physical material of optical discs breaks down over time; physical and chemical destruction of the reflective layer of the disc causes pits on the disc surface, known as CD (compact disc) rot or laser rot, and discoloration of the disc, known as CD bronzing. Any of these problems will eventually cause a disc to become unreadable.

The life-span of disc-based media is unknown. Based on rapid aging tests, media decay has been shown to affect discs created through lower-quality manufacturing and using low-quality materials, such as silver-based dyes.[4] While beta discs and other media printed on CD-Rs (compact disc-recordables) are at particular risk, bit rot has also been documented in formats as recent as Blu-Ray discs and Sega Dreamcast discs and will continue to be a problem well into the future.[5]

Uncertainty about the long-term stability of optical discs means that their longevity is of great concern. It is imperative that measures be taken to better understand the life expectancies of different kinds of optical disc-based games and the need to preserve them before the problem becomes as dire as that of magnetic storage media.

## ROM Cartridges

ROM cartridges are less affected by bit rot than other digital game storage media. ROM cartridges are made of durable material, and most commercial cartridge-based games are burned to masked ROM cartridges, which have considerably longer life-spans than most other digital media. However, ROM cartridges require protection to mitigate corrosion from moisture and battery acid, while restoration may also be necessary to preserve such functions as battery backup. The ultimate life-span of masked ROM cartridges is unknown, but it is possible that some cartridge-based games will last longer than the copyrights associated with them.

EPROM cartridges, however, are subject to more rapid digital decay.[6] EPROM cartridges store data by charging electrons inside the chip; over time, these charges will slowly leak through the chip insulation, causing irretrievable loss of information.[7] Current estimates suggest that EPROM cartridges can last upward of twenty-five years; many early cartridge-based games have already surpassed this age and demonstrated the effects of bit rot.[8] This places games stored on EPROM cartridges at risk and requires the implementation of measures to ensure their long-term preservation.

Battery failure is another form of data loss, as in the case of digital information stored in RAM (random-access memory) chips, which is deleted once the

chip loses power. For example, games based on Capcom CPS-2 arcade boards contain security codes stored in a static RAM (SRAM) chip powered by a battery. When the SRAM loses power, the board "commits suicide," and the security code is erased, making the game unplayable. Capcom currently offers a service for repairing the boards, though this service is not guaranteed to be available even ten years from now.[9]

### Conclusion

Because digital media's life-span is so short, preservation efforts must include data migration and refreshing from older, decaying media formats to newer formats. Unfortunately, this often conflicts with copyright laws. Therefore, efforts must be made to ensure the legality of digital media transfer for preservation purposes in libraries and archives. This is a contentious issue, but one that needs to be resolved for the security of our digital past and future.

### Obsolescence

Digital games, like all digital media, are also subject to obsolescence. Obsolescence occurs when older media formats are replaced by newer formats with greater speed, storage capacity, and functionality. When old media are replaced, there are no longer systems to support them, and they will not run on the latest software and hardware platforms. As a result, even if the medium on which a game's data is stored is able to last a hundred years, after only a fraction of that time, its data will be unreadable in the latest hardware and software environments. Additionally, media that are less durable and stored on obsolescent hardware will be more difficult not only to use but to preserve for long-term use.

Every media format undergoes obsolescence, and the media of today are no exception. When the VHS (video home system) tape was introduced, few foresaw how quickly it would be replaced by the optical disc. The optical disc, while currently backwards compatible from Blu-Ray to DVD (digital video disc) to CD, may not be a viable format even twenty years from now. And so on. Format longevity is never guaranteed. Market forces, rather than the needs of long-term preservation, usually determine the survival or disappearance of media formats.

Digital games are particularly susceptible to media obsolescence. Digital-game technology evolves rapidly, and, therefore, game hardware becomes obsolete faster than most other technologies. Only a few game platforms have ever had backwards compatibility, and even then, compatibility of older games with newer platforms has rarely been complete.[10] Several competing game platforms

are released with each generation so that the number of obsolete game systems presents a daunting challenge to those trying to preserve console games. Additionally, the personal computer platform is exponentially more complex, given the wide range of customizable hardware systems available, each of which affects game presentation and performance. These different hardware environments must also be considered when dealing with digital game preservation.

Software compatibility is also a significant issue for digital games. Personal-computer games and other software are only compatible with specific versions of operating systems, such as Windows XP and Mac OS, and these same operating systems only function within specific hardware environments.[11] Furthermore, all computer hardware use drivers, which are also only compatible with specific operating systems, further complicating requirements for preservation.

Because of obsolescence, it is imperative that we preserve the hardware and software environments that are required to run the games we wish to preserve: without the platforms to run them, the games themselves are useless. Unfortunately, the maintenance of old hardware and software environments is ultimately not feasible for long-term preservation due to the high costs of maintenance and the inevitable failure of computer components.[12] Long-term preservation will require methods such as data migration, which means transferring information from one hardware or software format to another, and emulation, which means replicating the exact operation of another hardware and software environment. These methods, in turn, raise significant issues with regard to ownership, copying, and migration of game software.

None of these problems can be solved without industry support. Indeed, the problems themselves are sometimes exacerbated by industry practices. Unfortunately, it is usually the case that the consequences of these problems are experienced by companies, consumers, and academic repositories only after the technical, marketing, or legal decisions behind them are themselves history. By then, it may well be too late.

*Industry Support Is Crucial*

The history of the game industry cannot be saved without support from its creators. Currently, there is no single institution within the game industry or in any government that is responsible for archiving digital games. There is no Library of Congress for games, only various independent efforts made by libraries and archives throughout the world, and there are few industry-operated archives for the preservation and documentation of a company's history. Because preserv-

ing digital-game history requires methods such as migration and emulation, support from the industry is required to overcome the many legal and technical barriers that currently prevent the preservation of its own history.

*Legal Support*. The first line of support that game companies can give libraries and archives is legal support. Digital Rights Management (DRM) licensing and copyright laws present barriers to the long-term preservation of digital games. While these laws were created to protect the intellectual property of the industry, they prevent the only viable techniques of long-term preservation: migration and emulation.

In order for digital media to survive decay and obsolescence, the information must be transferred, or migrated, from one storage format to another, which involves creating a copy. Sometimes, copy protection schemes prevent this process and must be overridden to secure a copy of the data. The physical act of simply copying the data may violate contract agreements and copyright laws. Additionally, the software and hardware platforms must be emulated, which can conflict with copyright laws governing hardware and software environments.

For long-term preservation, copyright holders must grant exceptions to libraries and archives so these tasks can be performed. It may well be that game companies and owners of game-related intellectual property do not object to game preservation by these institutions, but protocols for assigning these rights have yet to be worked out in a clear manner.

Additional legal support involves tracking ownership of copyrights and intellectual property rights for games that need to be preserved as well as verifying the existence of "lost" or missing games. Often, little information is known about older titles, making it difficult to determine ownership. The establishment of clearinghouses for such information, perhaps by trusted academic institutions or repositories, would benefit the industry as well as game preservation activities.

*Technological and Business Practices*. Developing sustainable distribution formats and business practices that support long-term preservation would benefit both game companies and repositories such as libraries, museums, and archives. Certain business practices such as digital distribution, server-side authentication, and installation verification are only some of the challenges that preservationists will face.

Digital distribution causes considerable problems for archives due to its reliance on remote storage. For instance, games distributed through Xbox Live Arcade (XBLA) are almost wholly dependent upon the longevity of the XBLA

service. If a title removed from XBLA, it would only be available on systems whose owners had purchased and downloaded the title.[13] Other streaming digital distribution services do not even allow the creation of local copies. Without changes in industry practices regarding distribution and copying, the long-term preservation of digitally distributed games will ultimately depend on the distributor.

Installation licenses and encryption key verification tools introduce additional problems for preservation. Installation licenses limit the number of times games can be installed. This limitation is useful in helping to prevent piracy but causes problems for long-term preservation. These practices ultimately tie copies of a game to a particular computer that will likely fail or become obsolete rather than to a particular user, who would have some flexibility in transferring the games to another computer. Moreover, encryption key verification tools often run on company servers whose life-spans may be limited to decades or, more likely, years. These services may not be operational in the future; when a validation service fails or is dissolved, games associated with it can no longer be verified and almost certainly cannot be run. Overcoming both problems will ultimately require industry support because companies create, own, and operate these services.

Lastly, online games provide a unique challenge, particularly Massively Multiplayer Online games (MMOs); these persistent game worlds require servers run or operated by game companies for a variety of functions. Libraries and archives are currently exploring various methods for how best to preserve MMOs.[14] But most of the preservation efforts may ultimately rely on a developer's or publisher's ability to preserve these titles for the long-term after their virtual world has shut down.

*Support for Industry and Company Archives.* The IGDA Game Preservation SIG also encourages companies to set up their own archives or records-management programs. Studios will ultimately benefit from having these local archives. Corporate records held in a company archives or records-management program let companies preserve materials for games currently in development and track copyright ownership. This same material can also pay dividends through practical applications such as training new developers and providing resources for game development: simply put, old code and prototypes can inform the development of new games. Additionally, some of these materials may have commercial value, as they can be used to create products such as retro game collections, art books, and soundtracks. Archives can be used to record the

history of a company, to promote pride in employees and their creations, and to prepare annual reports and marketing tools.

Due to the complex nature of digital preservation, some companies may not have the knowledge required to create their own archives. As a result, even their current production archives may already be at risk of data loss, to say nothing of their archives of years-old data stored on dusty floppy disks, creaky hard drives, and fading optical discs. The IGDA Game Preservation SIG can work with game companies interested in better managing their data and records by providing advice and assistance in creating long-term archives.

*Conclusion*

The problems of a general game library or archives are the same as those of a company or development studio's corporate archives, so cooperation between the industry and the archive will ultimately benefit both parties. With your support, together we can ensure the long-term preservation of digital games, along with their cultural and historical importance.

## Devin Monnens: Why Are Games Worth Preserving?

Digital games are disappearing. With each passing day, magnetic disks continue to decay and older computer hardware wears out or becomes obsolete, bringing the games that make up so much of our history closer to oblivion. If something is not done quickly, it will be too late to preserve our past. How do cultural artifacts survive? Works of art and other objects have lasted through the ages for a variety of reasons: they are made of durable materials (stone); they are copied before the originals are lost or destroyed (books); they are massive in scale (the pyramids); they are stored in environments that aid in their preservation (the Dead Sea Scrolls); they are moved away from wars, disasters, and iconoclasts; and, finally, somebody cared and took an active role in preserving them.

If digital games are to survive as business properties and cultural artifacts, we are the ones who have to care and take an active role in their preservation. But why should we preserve digital games? Why should we be concerned with preserving what many people consider to be a fancy toy, a waste of time, or—at worst—a corruption of our youth and society?

We need to preserve our games because they are important. They are important to our industry, to our culture, to our society, and to ourselves. They

are important because we make them and put heart and soul, blood, sweat, and tears into their creation: for that reason alone, we need to preserve them. Games are also a significant part of contemporary culture; as part of our culture, they are a part of what makes us human, and by learning from them, we can better understand ourselves.

### Games Are History

Digital games need to be preserved because they are history. They chronicle the rise of an industry that today rivals that of film, and they document the genesis of an art form of the twenty-first century. We must preserve this history because it defines who we are today and reminds us of our roots. Games are our legacy for the future, and we must take pride in our history. The past shows us how far we had to go to get to where we are today, and it puts into perspective how far we still have to go: the past is the prologue to the future.[15] In addition, we should preserve digital games out of gratitude to the developers who made them—many of whom are still alive today. Maybe you are one of those developers. Digital game development is not something that began a hundred years ago the way film production did; it is still a very young industry, and that makes it even sadder that these games are being lost so quickly. We need to preserve our history lest we forget who we are and forever lose an important part of what defines us.

### Games Are Property

Digital games are owned, as intellectual property, by the companies that design, produce, and distribute them. They are owned as tangible property by the consumers who buy the games and purchase an associated spectrum of materials ranging from clothing to published game guides. Both forms of ownership are jeopardized if the assets in question are too easily lost.

### Games Are Design

Digital games need to be preserved because they tell us about design. Just as good filmmakers learn from the films of the past, the game developers of today can learn a lot from the games that others have made. Game development is an art form, and as in any art form, we should not have to continue reinventing the wheel. Some studios recognize the need to teach their employees the history of the industry and to use old prototypes to inform the creation of new titles.[16] A game library or archives can serve as an excellent teaching tool for

future developers, just as it can be used by critics to examine the games of today in relation to the past. Such an archives also provides access to games we may have only heard about and which are no longer easy to find, making it a boon for students of game development as well as scholars.

Further, many games have unique elements in their designs that make them worth preserving in their own right. Games like *Adventure* (1979, Atari) and *Donkey Kong* (1981, Nintendo) were as much solutions to limitations of computer hardware as they were fun games. And yet, we should not limit ourselves to preserving the best designs, the masterpieces of fun. We have the potential to learn something from every game, regardless of how well or poorly it was made, for without failures, how can we know what failed to work and learn from it? Older games serve as much as a learning tool as they do a gallery of design, so it is important for the maturing game industry to recognize the significance of the past and apply it to the future.

### Games Are Art

Digital games need to be preserved because they are an art form: they have things to say about culture and the human condition through the languages of play, simulation, and narrative. Games have proven their capacity to explore and critique the nature of human culture and the world we live in, as well as reflect on their own nature as a medium.

Scholars are beginning to recognize games as an art form.[17] Some argue that early games like *Pac-Man* (1980, Namco) and *Final Fantasy* (1987, Square) may be considered art, and it seems clear that games possess an innate ability for expression.[18] Certainly, modern games such as *Ico* (2001, Sony Computer Entertainment), *Braid* (2008, Number None), and *Passage* (2007, Jason Rohrer) in many ways resemble works that some artists, critics, and curators would consider art. The number of games reaching and exceeding this level of appreciation will only grow as the years pass. Like comic books and animated films before them, digital games compose a medium that is gradually becoming accepted as a valid form of artistic expression. Its future expressive potential is slowly emerging as it extends its reach into new venues, including art museums.

As such, digital games need to be preserved both in order to document the history of an emerging art form and as works of art in their own right. We have lost many early films because no one preserved them, and many of these lost films had something meaningful to say about the world that produced them. Will we not also mourn the loss of early digital games a hundred years from

now if we allow them to suffer a similar fate? Digital games must be preserved to save their artistic values as well as their messages for posterity before they, like many early films, are lost.

### Games Are Culture

Digital games need to be preserved because they are part of contemporary culture. As a multibillion-dollar, international industry with digital games in 65 percent of American homes, as a social phenomenon frequently covered in the news, as a staple of contemporary pop culture, and as an emerging art form, digital games have had a profound impact on our culture.[19] The significance of this impact has yet to be fully realized, particularly because the digital game generation is still growing to adulthood. What will be the impact of digital games on the way we see the world? Will it be an influence as profound as that of other visual media like film or photography? The games we play tell us a lot about ourselves, and we play a lot of games. They are as much a part of our culture as television, newspapers, and books. Through understanding culture, we better understand ourselves. How can we understand our culture if we fail to preserve it?

### Games Are Fun

Digital games need to be preserved because they are fun. Fun is not something to fear or dismiss; fun and play are as much about being human as they are about enjoying our world. We enjoy many forms of entertainment, whether they are games, movies, books, or television programs, and indeed, fun and entertainment are things that make some of the best books and films last for generations. Games and play are an important part of human culture and may even be seen as a guiding force behind it.[20]

As much as we love personal entertainment, we also love to share things that we enjoy with others: if we read a book that we find compelling or enjoyable, we naturally want to tell others about it, to share the experience and to make others happy. When we see a beautiful sunset, we want to share it with our friends and loved ones to appreciate it together. And when we play a game we enjoy, we want to share it with others. What parents have not tried to introduce their children to a game they played when they were young? As much as a game developer's job is to produce a salable product, he or she also wants to make something that will bring enjoyment to others. We should preserve what gives us joy so we can share that happiness with future generations and continue to make the world a better place.

In other words, we should care that future generations might not be able to play our games.

## Zach Vowell: What Constitutes History?

With the significance of digital games in mind, we might well ask ourselves, What constitutes a history of digital games? We now recognize the importance of such a history (or histories), but what exactly do we need to preserve in order to facilitate its composition in corporate publications, on Web sites, in magazines, in journals, and in academia?

The central priority should be preserving the games themselves. After all, if a future game developer or historian cannot experience the gameplay, then all other issues will pale in comparison. On the other hand, if we place too much emphasis on preserving only published games, we relegate much of the history behind games to the shadows. To challenge this potential overemphasis on the games themselves, consider whether future historians could learn how a game was made by playing it, or whether the history of a development studio and the culture of the development team could be gleaned through such play. Similarly, could apprentice game producers compare successful development processes to unsuccessful ones when they play, say, an AAA-title alongside an unreleased game? Could biographers understand the key developers whose histories they write by playing the games those developers worked on? The answer to all these questions is no because the stuff of game history encompasses far more than the published games themselves.

We face many missed opportunities if we do not confront this universe of documentation head on. Who knows, maybe digital games will retreat from their impressive advance into modern American culture; maybe they will prove a passing fad. Maybe players will continue to play these games in the future, but their understanding of digital games' place in society will diminish, and consequently their sense of the worth of such games falter. In such circumstances, folks would not have to revile games as, say, childish pastimes now discarded; they might simply come not to care about them as much. That might be all it takes for games of the past to become objects of pure nostalgia, old abandoned joys found only in cabinets of curiosities rather than in archives, libraries, and museums.

On the other hand, documentation places digital games in their proper context and opens them up to serious attention—the kind of attention we give

histories of art or government. Archival documentation reveals among many other elements of humanity the thought, time, innovation, toil, and inspiration that go into the making of games.

So, we feel compelled here to begin a list of materials (and types of materials) in addition to the game software itself that would be suitable in archives where historians, writers, and other researchers, as well as companies, players, and fans, could find them and use them in their work. We say begin, because this is only the start of a list of things that could constitute game history. Archivists love nothing more than being educated by practitioners about what constitutes history. We hope that game developers and other IGDA members will take ownership and add to this list, whether by contacting the IGDA's Game Preservation SIG to update information on its wiki or by seeking out a local archival repository and asking if it would be interested in some documentation or an artifact, no matter how unusual it may be. The list we are about to present is necessarily incomplete: ideas about what is important will change over time.

Without further ado, consider the following list of materials. If you notice something in it that leads to a dusty trove in your garage, please also consider donating your valuable materials to the trusted repository of your choice. Such a repository will not only provide a potential home for these materials, but archivists there will help you work through issues of intellectual property and other legal matters that may arise. And remember that hard drives and other media that contain digital copies of these types of documentation are welcome, too.

> Design documents of all kinds
> Development-related correspondence
> Artwork such as conceptual art, sketches, and storyboards
> Versions of games, from original prototypes to patches, sequels, and mods
> Game-development source code, assets, tools, and the resulting binary executables
> Machinima, replays, and other recordings of game play
> Development-related maps (shadow maps, influence maps, texture maps, etc.)
> Wikis; subversion, sharepoint, and perforce directories; internal Web sites; notice-board notes and posters; and other collaborative and group media

Scheduling and planning documents

Developer or publisher budgets, forecasting, market research, and other business-related documentation

Other documentation related to the developer and publisher relationship

Company newsletters and circulars

Information on projects, teams, and company structures over time

Photographs and videos of the companies, people, and events (both internal and external)

Advertising and marketing materials, especially pieces used for unique, one-time purposes

Press kits and demos

Legal documentation

Books on game design, development, and game studies

Research papers produced by academics for developers

Source materials (i.e., writings, film, art, etc., that inspired a game)

PowerPoint and other presentations for conferences and meetings

Game magazines, including clippings files

Archival and business records or personal papers from groups, organizations, and individuals who are associated with the game industry but are not involved in game development

Looking over this list, we fully appreciate the legal concerns a developer might have when considering a donation of such materials: your company's team of intellectual-property lawyers probably leaps to mind. While these are serious concerns, you should also note that most established archival repositories have a long history of finding the delicate balance between protecting their donors' interests and providing researchers access to the materials they need for their work. What we need from game companies is for them to determine what level of access to their historical materials they will allow.

Another way to think of historical documentation is in its capacity as evidence. An archival theorist, Hilary Jenkinson, noted that "the outstanding feature of the Archive, putting this at its simplest, is that it is by its nature unique, represents some measure of knowledge which does not exist in quite the same form anywhere else." In the same breath, Jenkinson also recognized "the possibilities of Archives as evidence, as correctives of the more or less *ex parte* statements of contemporary or later commentators on events."[21]

Where digital-game history is concerned, ask yourself if you have ever been involved in a dispute at your company. Was some decision wrested from your hands, such that the resulting game suffered as a result? Has a design decision been controversial? Do you know of an unsung developer who never gets the credit he or she deserves? Does some aspect of the game industry go unnoticed or, conversely, is it often overemphasized? Or hang it all, do you just want your work to be commemorated? To be sure, evidence you might think is important for documenting how games are made or what decisions were made in your company need not have legal significance—it just begs to set the record straight.

Finally, allow us to devise a different kind of list. This list merely implies the possible types of documentation by describing the many aspects of digital games that might be documented.

*Games Are Fun*. People play games, and that often-discussed word fun will no doubt be debated endlessly as the years pass by. How exactly have developers made fun games?

*Games Are Art*. Art historians and literary scholars have always been interested in the processes that inform a finished work of art. Games will be no different—investigating how games are created will also enhance the appreciation of them.

*Games Are Business*. After all, some might say, business is no fun. But conducting business is the industry's lifeblood, and there will always be people who want to study how that lifeblood ebbs and flows and affects the games that the company produces. Some will study accounting, marketing, or entrepreneurship; others will compare the results of big companies to the feats of an inspired independent producer.

*Games Are Digital*. With so much of the game industry conducted in a binary number system, it seems obvious that much of its documentation exists in digital form. Yet, so often people dismiss their digital hoards, which destroys digital documentation needed by future researchers and historians studying the game industry.

*Games Are Advertisements*. The world of game play may not contain much advertising (though the rise of in-game marketing may change that), but game production often includes advertising, marketing, and publicity efforts that inextricably become linked to our experience of the game.

*Games Make Statements*. True, with interactivity, the statement changes from player to player, but the statement is still there; and the game's designers

craft the rough outlines of each statement with the rules, parameters, and narratives in their games.

*Games Say Something about Us.* The reverse is true too: games allow us to express ourselves through play, whether it's a high score and style of attack in *Space Invaders* (1978, Taito) or a chosen occupation and power level in *World of Warcraft* (2004, Blizzard).

The possibilities for exploration are endless, and the more evidence we gather, the better our understanding of all these facets of games is deepened. However, if we ignore the problem of game preservation, those possibilities will be lost.

## Judd Ethan Ruggill and Ken S. McAllister: What If We Do Nothing?

Whenever archivists and collectors assemble, their conversation inevitably turns to a question that always proves vexatious in a self-congratulatory way: What if nothing is done to identify, locate, catalog, and preserve this material? Among such confederacies, this material could be anything from Khmer folk ware or Scottish incunabula to antique jack planes and back issues of *Penthouse*. In any case, the anxiety at the heart of this question—What if we do nothing?—is simultaneously an expression of value, a fear of regret, and a condemnation of the short-sighted masses.

At a certain level, though, the question at hand—What if we do nothing to archive and preserve digital games?—is spurious: collectively, we (i.e., publishers, players, pundits, and scholars as well as developers) do nothing every day. Rather than collaborate systematically to conserve the cultural and material heritage of our medium, we go about the process of preservation idiosyncratically and haphazardly, if at all. We carefully preserve some things (e.g., limited-edition consoles, games, and memorabilia), casually discard others (e.g., poorly rated games, game packaging, and documentation), and generally think more about present and future titles than past ones. Occasionally, fortune smiles, and a case of well-preserved games or consoles is discovered in a long-neglected back room or storage closet. More often, tastes and technologies change, and old games (i.e., titles more than ninety days old) simply—and perhaps naturally— fade from view. The art and practice of digital-game preservation is left to hobbyists and collectors, whose interests, archival sensibilities, and preservation

expertise vary greatly and who are often less concerned with the importance of art, labor, organization, and memory than the market value of rare goods.

The question (What if we do nothing to archive and preserve digital games?) is misleading because in calling for an answer, it obscures the fact that ultimately there cannot be one. Once a game is lost (and not merely misplaced or forgotten), it is gone forever. One cannot suddenly produce a copy and then contrast the state of the art—to answer "what if"—prediscovery and postdiscovery.

And yet, the question of inactivity, of doing nothing about game conservation, lies at the heart of this white paper. Indeed, it lies at the heart of the digital-game medium itself. For the development, play, and study of games can take place only in the context of their antecedents, in the context of all of the games that have already been developed, played, and studied. In this sense, conservation is a part of every game-related act, from design and development, to marketing and play, to analysis and storage. Each of these actions, alone and collectively, forms a part of the logic by which people understand what a digital game is, how and why it works, what it takes to bring one from concept to completion, and the pleasures and problems a game, its development, and play are capable of producing.

Unfortunately, this logic is impoverished by the vagaries of memory. The human mind is as porous as it is prodigious, allowing some things to escape just as others are retained in intricate detail. One might well recall the fun of *Time Pilot* (1982, Konami) or *Boogerman: A Pick and Flick Adventure* (1994, Interplay Entertainment), for example, but perhaps not the specific mechanics underpinning the fun. Yet, it is precisely these specifics where, so to speak, the finger meets the nostril because the mechanics provide the context for and the inner windings of the fun these games afford. Game preservation is thus both a mnemonic act (i.e., it spurs researchers to remember details that would otherwise be forgotten) and a creative act (i.e., it leads to the generation of new historical knowledge); preservation mitigates the leakiness of memory and provides the kind of functional detail that is crucial to spurring the growth and creativity of the medium.

The same is true for other media. Film, in particular, provides an excellent case study on the value of preservation. Despite the fragility of film stock—celluloid is in many ways far more delicate than most forms of media storage—films of all kinds and of all eras have been incredibly well preserved across a variety of institutions, from local collections (e.g., Fukuoka City Public Library Film Archive and Provincial Archives of New Brunswick) to university archives

(e.g., University of the Witwatersrand Archives and UCLA Film and Television Archive) to national centers (e.g., Laos National Film Archive and Video Center and National Film Archive of Iran). These widespread conservation efforts have sustained the cultural, economic, educational, and creative viability of the medium for more than a century through a host of challenges from competing media such as television, the Internet, satellite radio, cellular telephony, and digital games. One need only look to the proliferation of film festivals around the world or to the remarkable and influential power of the Hollywood star system to see that the medium possesses a cachet distinct from that of other media, a cachet due, in large part, to the enduring record of the films of the past and the ways in which that record continues to influence film production, consumption, and study today.

Ultimately then, despite some reservations about the question, What if we do nothing? we feel obliged to attend to it. The fact of the matter is that materials do go missing, and virtually all of these materials would contribute to the historical understanding of the digital game were they to be found. We turn then to a very brief catalog of the problems of doing nothing for game preservation.

*Examples*

The number of known instances in which digital-game material has been lost is quite large, and they fall into a variety of categories. We will not cover them all in this section of the white paper but, rather, we will treat three of the most important gaps in the record, the locales of absence: source code for unreleased games, published games, and ephemera. These sections are by no means comprehensive; rather, they are intended to outline the rough circumferences of the major historical sinkholes for digital games as a way both to flag work yet to be done and to suggest the range of probable consequences should the work go undone.

*Source Code for Unreleased Games.* Daniel Bienvenu has documented nineteen games for the ColecoVision System that were advertised—including screenshots—but never released. The whereabouts of these games and their source code is unknown.[22] The researchers at Games That Weren't, a Web-based archives of information related to lost games for various platforms, have identified more than seventy-five games that made it into the alpha stage of development (at least), but then vanished.[23] This issue plagues the latest consoles as well: researchers at Unseen64.com, for instance, have documented

at least sixteen titles for the PlayStation 3 that have been canceled since the system was released. Mothballed games are not necessarily permanently lost, of course, nor should such titles necessarily be released to the public. There are more than enough bad games on the shelves as it is. It is important for those committed to game preservation to recognize these stoppages, however, because stopping work on a game is often the first step in its complete disappearance. A well-funded game is canceled, the developer cut loose, the physical studio packed up and closed down, the hard drives stored, ruined, and lost. Studying failure is often highly beneficial, but in cases of complete disappearance, there is nothing left to study.

*Published Games.* There also exist many lost titles that actually made it through the development process and were even distributed to stores. Calling these games "lost" is perhaps an exaggeration; even in the rarest of cases, dedicated collectors will have secured copies for their private collections. Such isolated copies, however, do little for future game development or game studies because they cannot be accessed by anyone but the collector; they are thus functionally lost. Here are some examples:

> *Mr. Boston* was a Vectrex-based 1983 promotional adaptation Clean Sweep developed for the Mr. Boston distillery in Massachusetts. It is considered ultrarare by collectors, and auction prices reflect its scarcity.
>
> *Shootout at Old Tucson* for the 3DO is believed to be a one-of-a-kind game developed in 1994 by American Laser Games.
>
> *3-D Rubik's Cube* was designed by Peter Niday for the Atari 2600 Video Computer System (VCS). Approximately three hundred copies are known to exist.
>
> *American Hero CD*, designed for the Atari Jaguar system in 2003, was the first Jaguar game to use extensively full-motion video and is only one of two games for the system that used David Schwartz's Jaguar GameFilm technology.
>
> *Les Schtroumpfs Autour du Monde* (The Smurfs Tour the World) was the last Sega Master System game released in Europe. Since its release in 1996, fewer than one hundred copies have been located.

Each of these examples holds important details about the game industry that cannot be determined at present because these games are inaccessible.

*Mr. Boston* is one of the earliest instances of a game mod as well as of a corporate digital game. *Shootout at Old Tucson* is remarkable for its tie-in not to movies—standard fare by 1994—but to an actual movie set that served as the location for dozens of classic western films. Peter Niday's *3-D Rubik's Cube* not only demonstrated how frenzied the Rubik's Cube craze became (Atari had two versions of the puzzle for its VCS), but also broadly extended the game play boundaries of the Atari 2600 hardware with some of the system's most brilliant programming. And *American Hero CD* and *Les Schtroumpfs Autour du Monde* were both swan-song games for two marginally successful and internationally distributed systems, which is to say that they are milestone games that only the tiniest fraction of players, developers, and researchers have been able to play.

*Ephemera*. Finally, there is the loss of all the peripheral material that surrounds game systems, from game documentation and memorabilia to tie-in products and corporate communications. Here again, the known losses are great and are likely dwarfed by the unknown losses. Hundreds of development studios have started and folded over the past half-century, most of them having made only small contributions to the history of the electronic games. Considered individually, these studios and their creations may be relatively insignificant. Collectively, however, these numerous companies—their games, vision statements, financial structures, leadership, development models, and so on—add up to a highly detailed history of the industry and the medium it is built around. As a consequence, the loss of any material from these companies equates to missing pieces of the puzzle which researchers assemble to interpret their subject. This lack is not only a loss for designers interested in learning about the past in order to make better games in the future, it is also a loss to all the other people in the game industry who might benefit from knowing what has come before in their particular professions: legal papers, business plans, industrial designs, technical specifications, management strategies, marketing schemes, and innumerable other documents and materials.

## What If We Do Something?

In his essay, "The System of Collecting," French philosopher Jean Baudrillard writes, "What makes a collection transcend mere accumulation is not only the fact of its being culturally complex, but the fact of its incompleteness, the fact that it lacks something. Lack always means lack of something unequivocally defined: one needs such and such an absent object."[24]

From this perspective, the serious work of game preservation would be a never-ending commission from the outset. Were such a charge to be proffered, however, the results would be prolific and profound. Indeed, Baudrillard observes that collectible objects "constitute themselves as a system, on the basis of which the subject seeks to piece together his world, his personal microcosm."[25] This intimate and microcosmic system of collecting has sustained digital-game history for decades, but its limitations are now becoming painfully clear to researchers—whether from industry or academia—whose vision of the future is increasingly hindered by accidental ignorance of the past.

Computer historian Kevin Schurer remarks in his essay, "The Implication of Information Technology for the Future Study of History," that there are many countervailing forces acting upon the preservation of electronic media, but he argues that the most fundamental implication is inherent in digital media themselves.[26] Contrasting traditional archivists dealing with volumes of paper-based material—letters, notebooks, drawings, reports, memos, and other documents—that attest to a person's ideas and achievements, archivists of the digital age routinely deal with far more evanescent artifacts. While these artifacts tend toward the transitory, if an effective set of principles and practices could be developed for digital-game preservation—and collectively adhered to—the history of this medium has a chance to become a tool for understanding its present and future incarnations.

## Andrew Armstrong: Some Possible Solutions

While the state of digital-game preservation seems bleak, there are many active efforts to preserve digital games, and you can help us in focusing attention on items that are worth saving now, or in coming up with better ways to ensure preservation of games and other materials that will become important in the future.

*Current Archiving Efforts*
Throughout the world, various museums and archives are working to preserve the history of computer systems and digital games. They do this usually through donations of hardware and games and other software that is preserved for public display and for research.

There are also academic projects to help preserve digital games, specifically researching the need to preserve the games themselves, as well as document how they were made. The histories of different areas are also being researched and recorded via documentary films, books, and online resources. Internet databases dedicated to different systems, developers, and series of games all exist and are constantly updated.

*Museums.* There are many computer museums around the world. Many of these institutions collect game software and hardware as parts of computer history.[27] These museums usually house archives of software and manuals, but their main purpose is putting on displays for the public. However, computer museums concentrate on a broad range of computing fields; therefore, collections and projects devoted to game systems work might be less of a focus for the museum.

*Archives.* Archives hold documentation and related materials for researchers to access; the emphasis is on the organization of collections and the provision of access to them, rather than on public displays and exhibitions. Some archives house digital-game material in addition to more general computer-related work.[28] Other archives focus solely on the history of digital games.[29] There are also online archives and catalogs of digital material, such as the Internet Archive, that contain games and game-related material.[30] These sources readily accept important items related to digital games.

*Projects.* Throughout the world, different projects help to preserve digital games. Examples include the Preserving Virtual Worlds project, funded by the Library of Congress and based at four U.S. universities, and National Videogame Archive of the United Kingdom (UK), which has created a promotional effort called Save the Videogame.[31] In addition, there have been exhibits and displays on the history of digital games, such as *Game On*, a traveling exhibition that has opened at several sites including the UK's Science Museum, the Computer History Museum, the Australian Center for the Moving Image, and, most recently, at the State Library of Queensland, Australia.[32]

## Individuals

Individuals and small groups also work on the preservation of digital games. Examples include Jason Scott's work on his *Get Lamp* documentary on the history of text adventures, the efforts of a great number of private collectors, and books on the history of various companies, systems, or types of games.[33]

Individual collectors typically help documentation efforts by providing information to databases, caring for personal collections of games, and conducting their own research into areas of interest.

*How Can You Help?* If you have ever worked on a digital game or in the industries related to them, you probably have physical items or digital artifacts (documents, screenshots, videos, software) that are important for the work of preserving our medium's history. We listed categories of useful historical materials in a previous section and ask that you consider donating them to your favorite or nearest museum.[34] If you do not know one, just contact a member of the IGDA Game Preservation SIG for advice.

If for any reason you do not currently wish to provide public access to material in your possession, consider the option of donating it for inclusion into so-called *dark* archives, which generally deny or restrict access to the materials for a stated period of time.

*I Cannot Donate Right Now.* It is likely that you or your company own copies of games or archival materials of historical interest that you are not ready to donate to a repository. Perhaps you still need them for game development or as a means for documenting intellectual property that you own. You should still consider contacting one of the archives or libraries listed in this white paper. Consider archiving them for now in a trusted or institutional repository (such as a corporate library or company archives) while providing information about them to a historical archives or museum. Curators are probably interested in knowing about material that will be available in the future; in some cases, they may prepare lists so both you and they can keep track of these materials. You might find it easier to place what you have after consulting with archivists or librarians. This is very useful step in regard to digital games being produced today.

*How About Things Not Written Down?* In addition to any physical documents or digital files, your own role in making digital games is an important part of the historical record, and there may be ways to document it. Much of the past is lost when people do not have their own histories recorded. International efforts are currently underway to accomplish this goal via the IGDA Game Preservation SIG. Many museums and archives conduct oral-history programs, while private consultants can help to organize a companywide oral-history project.[35] If you start up such an effort, please let the IGDA Game Preservation SIG know about it.

*Is There Any Way I Can Help If I Do Not Have Material to Contribute?* Even if you have none of the materials discussed in this white paper, there is plenty of volunteer work to be done toward recording the history of digital games.

You could start by joining the IGDA Game Preservation SIG and help with our projects, or by providing sponsorship or donations to the various organizations trying to preserve the history of digital games. Even just paying a visit to museums and archives that do such work will make it worthwhile for them, and the visit might spark your interest in game preservation or history.

Finally, getting the word out that digital-game history is being lost would help bring attention to the problem. People need to realize that they have to start preserving now, not tomorrow, and that there are organizations that require their help.

### What Do We Need to Do Next?

This is the first of two IGDA Game Preservation SIG white papers. Now that we have provided a call to action, we feel obligated to offer some solutions. The next step is laying out the best methods for preserving digital games and related archives, letting developers know what they can do during the production process to further the preservation of their games, and providing working practices for both archives and companies. While museums and archives hold some material, much of it will be retained by companies and individuals who should know the best way to store physical materials and software to keep these materials safe and secure for the future. Therefore, our next white paper will focus on how you can preserve what you own. This will benefit companies that hold copies of all their games and documentation materials and need help in managing them for long-term preservation.

### Appendix: Museums and Archives

For the full list of contact information for museums and archives accepting contributions check: http://www.igda.org/wiki/Game_Preservation_SIG/Contributions

#### Online Media Archives
Internet Archive Videogame Collections, http://www.archive.org/details/gamevideos
Software Preservation Society, http://www.softpres.org/

#### North America
Computer History Museum, California, http://www.computerhistory.org/
DigiBarn Computer Museum, California, http://www.digibarn.com/

Stephen M. Cabrinety Collection in the History of Microcomputing, Stanford University Libraries, http://library.stanford.edu/depts/hasrg/histsci/index.htm

National Center for the History of Electronic Games, http://www.ncheg, at Strong National Museum of Play, New York, http://www.museumofplay.org/

UT Videogame Archive, Texas, http://www.utvideogamearchive.org/

*Europe*

Association MO5.com, France, http://mo5.com/

The Centre For Computing History, United Kingdom, http://www.computinghistory.org.uk/

Computer Game Museum, Germany, http://www.computerspielemuseum.de/

The National Museum of Computing, United Kingdom, http://www.tnmoc.org/

The National Videogame Archive, United Kingdom, http://www.nationalvideogamearchive.org/

Retro Computer Museum, United Kingdom, http://www.retrocomputermuseum.co.uk/

Silicium, France, http://www.silicium.org/

*Rest of the World*

If you know of any further archives or museums that accept digital game material, please contact the IGDA Game Preservation SIG.

## Notes

1. Software Preservation Society, "Bit Rot," http://www.softpres.org/glossary:bit_rot.

2. Ibid.

3. As part of the "Preserving Virtual Worlds" project sponsored by the U.S. Library of Congress, the Stanford Libraries have identified unreadable floppy diskettes in the game collection for games published as recently as the mid-1990s.

4. Chandru J. Shahani, Basil Manns, and Michele Youket, "Longevity of CD Media Research at the Library of Congress," Library of Congress, Preservation, http://www.loc.gov/preserv/studyofCDlongevity.pdf; Jerome L. Hartke, "Measures of CD-R Longevity," Media Sciences, Inc., July 17, 2001, http://www.mscience.com/longev.html; Bronzing is caused by a chemical reaction from the aluminum coating in CDs to sulphur components normally found in CD booklets and inserts. The result is a gradual discoloration of the disc and eventual unreadability. L. David Lampson, "CD Bronzing," Classical Net – Koussevitzky Recordings Society, September 1995, http://www.classical.net/music/guide/society/krs/excerpt3.php.

5. Conrad Quilty-Harper, "Blu-ray Disc Coatings Starting to Rot?" Engadget June 16, 2007, http://www.engadget.com/2007/06/16/blu-ray-disc-coatings-starting-to-rot/;

Shadow460, "Laser Rot Occurs on Dreamcast Games," Post #1, Atari Age, October 12, 2008, http://www.atariage.com/forums/index.php?showtopic=132948.

6. Blackjax, "A Small Lesson in Bit Rot," System Failure, December 8, 2005, http://my.ais.net/~xtreme/SF/Bit-Rot/.

7. Ibid.

8. Ibid.

9. The CPS-2 Suicide Information Page, CPS-2 Shock, http://cps2shock.retrogames.com/suicide.html.

10. Compatibility regards not only whether or not the software will run but also whether the software will run in a form identical to how it would run on the original hardware.

11. For instance, Mac OS9 will only function natively on computers with PowerPC architecture, and not on the newer Intel chipsets.

12. Maintenance of computer systems for preservation, or "the museum approach," is merely a short-term, stop-gap strategy incapable of long-term viability. Mark Guttenbrunner, "Digital Preservation of Console Video Games," Vienna University of Technology, October 2007, http://www.ifs.tuwien.ac.at/~becker/pubs/guttenbrunner _games2007.pdf. These findings concur with those of Cornell University's Digital Preservation Management studies, http://www.icpsr.umich.edu/dpm/index.html.

13. Microsoft has "set parameters by which [they] can delist," but as of this writing, there appear to be no plans for title delisting. Kris Pigna, "TGS 08: Microsoft Holding Off on Delisting XBLA Games," 1UP, October 12, 2008, http://www.1up.com/do/newsStory?cId=3170592.

14. For example, the U.S. Library of Congress's National Digital Information Infrastructure Preservation Program (NDIIPP) has funded the "Preserving Virtual Worlds" project as part of its Preserving Creative America program. The project is being carried out by a group of universities: University of Illinois, Stanford University, University of Maryland, and Rochester Institute of Technology.

15. Cornell University Library, "Introduction, Digital Preservation Management Tutorial," Inter-university Consortium for Political and Social Research, http://www .icpsr.umich.edu/dpm/dpm-eng/timeline/index.html.

16. For example, designers such as Warren Spector and Will Wright have used older designs to develop rapid prototyping techniques or to train new developers.

17. Henry Jenkins, "Art Form for the Digital Age," *Technology Review*, September/October 2000, http://www.geocities.com/lgartclass/handouts/ArtfortheDigitalAge/ArtFormfortheDigitalAge.html.

18. Nic Kelman, *Video Game Art* (2005); Steven Poole, *Trigger Happy: Videogames and the Entertainment Revolution* (2000); Ian Bogost, Ernest Adams, and Ed Rothberg have all forwarded theses of this nature.

19. Entertainment Software Association, "Industry Facts," http://www.theesa.com/facts/index.asp.

20. See the writings of Johan Huizinga and Roger Caillois for more thoughts on these topics, especially Huizinga's masterful *Homo Ludens*.

21. Hilary Jenkinson, "Reflections of an Archivist," in *A Modern Archives Reader: Basic Readings in Archival Theory and Practice*, ed. Maygene Daniels and Timothy Walch (1984), 15–21.

22. Daniel Bienvenu, "Unreleased Games," Daniel Bienvenu's ColecoVision Home-Page, http://www.geocities.com/newcoleco/unreleased/unreleased_en.html.

23. Games That Weren't, http://gtw64.retro-net.de/.

24. Jean Baudrillard, "The System of Collecting," in *Cultures of Collecting*, ed. John Elsner and Roger Cardinal (1994), 7–24.

25. Ibid.

26. Kevin Schürer, "The Implications of Information Technology for the Future Study of History," in *History and Electronic Artefacts*, ed. Edward Higgs (1998), 155–68.

27. International Game Developers Association, "Game Preservation SIG/Contributions," IGDA Wiki, http://www.igda.org/wiki/Game_Preservation_SIG/Contributions; The National Museum of Computing, http://www.tnmoc.org/.

28. Stephen M. Cabrinety Collection in the History of Microcomputing, Stanford University Libraries, http://library.stanford.edu/depts/hasrg/histsci/index.htm.

29. The UT Videogame Archive, The University of Texas at Austin, http://www.utvideogamearchive.org/; The National Videogame Archive, http://www.national-videogamearchive.org/.

30. Internet Archive, Moving Image Archive, Videogame Videos, http://www.archive.org/details/gamevideos.

31. Preserving Virtual Worlds, http://dev.prairienet.org/; Save the Videogame, http://www.savethevideogame.org/.

32. Barbican International Enterprises, "Game On," http://www.barbican.org.uk/bie/exhibitions/game-on.

33. Get Lamp: The Text Adventure Documentary, http://getlamp.com/; International Game Developers Association, "Game Preservation SIG/Resources," IGDA Wiki, http://www.igda.org/wiki/Game_Preservation_SIG/Resources.

34. International Game Developers Association, "Game Preservation SIG/Resources," IGDA Wiki, http://www.igda.org/wiki/Game_Preservation_SIG/Resources.

35. International Game Developers Association, "Game Preservation SIG/Oral Histories," IGDA Wiki, http://www.igda.org/wiki/Game_Preservation_SIG/Oral_Histories.