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'Grand Theft Archive': A Quantitative Analysis of the Current State of Computer Game Preservation

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Abstract

Computer games, like other digital media, are extremely vulnerable to long-term loss, yet little work has been done to preserve them. As a result we are experiencing large-scale loss of the early years of gaming history. Computer games are an important part of modern popular culture, and yet are afforded little of the respect bestowed upon established media such as books, film, television and music. We must understand the reasons for the current lack of computer game preservation in order to devise strategies for the future. Computer game history is a difficult area to work in, because it is impossible to know what has been lost already, and early records are often incomplete. This paper uses the information that is available to analyse the current status of computer game preservation, specifically in the UK. It makes a quantitative analysis of the preservation status of computer games, and finds that games are already in a vulnerable state. It proposes that work should be done to compile accurate metadata on computer games and to analyse more closely the exact scale of data loss, while suggesting strategies to overcome the barriers that currently exist.

Introduction

> "Digital documents last forever - or five years, whichever comes first." (Rothenberg, 1999)

Since the first commercial arcade game was released in 1976 (Wolf, 2001, p.1), computer games[1] have grown into a successful global industry. In 2001, the European leisure software industry alone was worth nearly £3billion annually (Smith, 2006). The British games industry is the world's third largest developer of games after the U.S. and Japan (Katsumata, 2006; UK Trade and Investment, 2006). Computer game development is commonly taught in higher education,[2] and recently a number of British universities opened the Game Republic Academy, a specialist institution dedicated to providing high-calibre graduates to the industry (University of Bradford, 2007). In addition Douglas Lowenstein, President of the Electronic Software Association (ESA), commented that

> The video game industry is entering a new era, an era where technology and creativity will fuse to produce some of the most stunning entertainment of the 21st Century. Decades from now, cultural historians will look back at this time and say it is when the definition of entertainment changed forever. (ESA, 2006, p.1)

Unfortunately, at a time when computer games are taking their place, at least financially, alongside the established mediums of film and music,[3] remarkably little effort has been made to ensure the medium survives for future historians. A number of books cover the history of gaming with thoroughness and style (Chaplin and Ruby, 2005; DeMaria & Wilson; 2002, Herz, 1997; King & Borland, 2003). None, however, gives particularly close scrutiny to the idea of preserving the artefacts they discuss, even when they recognise the problems involved in accessing the games for research purposes (Wolf, 2001, p.183). Little has been done to preserve computer games, little research has been undertaken to define the problem,[4] and much has already been lost. The aim of this paper is to attempt to quantify the loss of our gaming heritage, and to reach an understanding of exactly why games have been so sporadically preserved.

The Current Preservation Situation

To some, the idea of preserving games seems ridiculous, as *The Independent* (2006) sarcastically points out: '…we remember when software was new! And now you're saying it's old?' Despite such opposition, campaigners are beginning to demand

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[1] Throughout this paper, the term 'computer game' will be used to cover all forms of software-based game, including arcade games, video games and PC games.

[2] Computer game studies cover a wide range of more traditional disciplines, as well as the relatively young field of ludology. There is a number of principal texts in this area, including Huizinga's (1944) *Homo Ludens* among others (Caillois, 2001; Sutton-Smith, 1997). Pearce (2002, p.144) argues forcefully that the development of a field of study dedicated purely to games is essential: 'Film and literary theorists… are missing a fundamental understanding of what games are about… the result is a kind of theoretical imperialism.'

[3] There is an increasing interest in computer games as a recognised art form, although this is yet to receive widespread acceptance (Mayfield, 2001; Sandor & Fron, 2001; Sutton-Smith, 1986).

[4] Gieske (2002) has written a dissertation looking at the issues that public exhibitions of computer games face in the heritage sector, including a close examination of the exhibitions of the Computerspiele Museum (2007) and the touring Game On exhibition that was later shown at the Science Museum (2007). Unfortunately, it covers few of the issues most pertinent to this question, most importantly lacking an understanding of the necessary preservation of games in order to produce such exhibitions.

serious consideration of the issue (Lowood, 2002, 2004). This has brought positive results in the United States, where archives have been granted an exception to the Digital Copyright Millennium Act, allowing circumvention of copy protection in specific circumstances:

> Computer programs and video games distributed in formats that have become obsolete and that require the original media or hardware as a condition of access, when circumvention is accomplished for the preservation or archival reproductions of published digital works by a library or archive. (Kahle, 2006)[5]

The Stephen M. Cabrinety Collection in the history of Microcomputing at Stanford University's (2007) special collections consists of computer software and hardware, dating primarily from the 1980s and 1990s, and contains 6,300 games for 27 different operating systems.[6] The University of Texas[7] is also opening a new archive, the UT Videogame Archive, comprising the private collections of a number of prominent games industry figures. It has not yet secured the necessary funding to make its collection available to the public (Rockwell, 2007). The Classic Software Preservation Project (CLASP[8]),[9] in partnership with the Software Preservation Society[10],[11] has begun to digitally store some older games, and the Library of Congress recently announced considerable investment to develop such collections (Krotoski 2007). Additionally, the Computerspiele Museum (2007) in Berlin[12] and Ritsumei University (2006)[13] in Japan have also created archives. However, finding detailed information on their holdings proves difficult. In the United Kingdom there is no recognised public archive, and the coverage of existing archives is extremely small in comparison to the wealth of games that has been released.

There is also a problem with proper documentation; of the few archives in existence, public holdings information is only available for the Cabrinety Collection and Software Preservation Society. The University of Texas openly admits that it requires $150,000 in order to make its collection accessible to the public (Rockwell, 2007). As Wolf (2001, p.183) points out, "even finding such information as the year of

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[5] It is worth noting that it seems only one group has so far utilised this exception. The Internet Archive http://www.archive.org/ is using the ruling to research and archive software, and was one of the main parties to lobby for the exception to be passed. This is perhaps indicative of a dearth of similar projects currently underway.

[6] More information can be found at http://www-sul.stanford.edu/depts/hasrg/Histci/index.htm

[7] The UT Videogame Archive http://www.cah.utexas.edu/projects/videogamearchive/ .

[8] CLASP: The Internet Archive: Classic Software Preservation Project http://www.archive.org/details/clasp

[9] The Internet Archive founded The Classic Software Preservation Project in 2004, to help archive obsolete software. As such, its holdings are not limited to computer games http://www.archive.org/details/clasp

[10] Software Preservation Society http://softpres.org/

[11] Formerly the Classic Amiga Preservation Society, the Software Preservation Society is dedicated to preserving mainly game software for the future. See http://www.softpres.org/ . It has a list of the games that it has successfully preserved available on its website.

[12] The Computerspiele Museum opened the first permanent exhibition of interactive entertainment in the world in 1997. It has since been responsible for a number of exhibitions, both nationally and internationally. For more information, see http://www.computerspielemuseum.de .

[13] Professor Hosoi Koichi manages Ritsumei University's videogame archive. It currently claims to have a complete collection of Nintendo's game releases, but the extent of its holdings is unclear. The only information available in English is a press release at http://www.ritsumei.ac.jp/eng/newsletter/winter2006/videogames.shtml

release for an older game can be hard." Unfortunately, it is unclear how much information has already been lost. The work undertaken in this research is important precisely because it is clear that current preservation attempts are inadequate. The problem is a multi-faceted one, and this paper approaches it from a number of angles.

Technical and Cultural Issues

As well as considering the existing level of preservation, we must also give thought to the wider issues involved. Technological strategies for digital preservation are, in many cases, inadequate for the unique archival needs of computer games. They face the same basic problem as other digital forms: 'will this digital media be available in 50 years and will there be a machine capable of reading it?' (Borghoff, Rodig, Scheffczyk & Schmitz, 2003, p.vii). The interactive nature of games makes this availability even more problematic; outside factors such as human input and faithful recreation of hardware and input devices can influence the gameplay experience greatly. This problem needs to be addressed, and establishing an understanding of why games have not been preserved is essential to future efforts.

Technology preservation is the easiest way to recreate original gameplay conditions, yet remains 'likely to work best over the short-term only' (UNESCO, 2003, p.126). A technological approach to computer game preservation has not been established, as the medium produces difficulties that have not been broached by traditional archives. Games are a dynamic experience; shaped by the interaction of player, software, hardware and game design, and occupying 'a media space somewhere between the text, the experience and the performance' (Lowood, 2004). Traditional preservation strategies are built on an understanding of fixity, effectively placing an object in stasis so that it may be experienced in its original form.

Among gaming enthusiasts there is a thriving illegal emulation[14] community, (emuscene), which is currently the largest source of historical game information: the community preserves computer game history by methods including web-based catalogues of classic games,[15] screenshots and box artwork collections, and full emulation of old games.[16] The long-term viability of this type of community-based emulation is questionable, as it is effectively illegal (Federation Against Software Theft, n.d.), has perceived links to software piracy (Nintendo, 2007), and limited skills and funding increase the likelihood of activity being abandoned with little warning (Zach, 2007). An overview of the community suggests that these factors all contribute to the diminished value of the community's well-intentioned work (Saltzman, n.d.) The hobbyist nature of the work done also means that the community is vulnerable to skill loss, erratic decision making and basic loss of interest among participants.[17]

Emulation then, is not preservation of the original game, although in many cases it is the best representation that is available. Such efforts protect very few vulnerable games. Meanwhile, we risk losing much of gaming's early history. The lack of UK-

[14] Based on the principle of 'simplify[ing] digital preservation by eliminating the need to keep old hardware working' (Thibodeau, 2002, p.19), emulation aims to overcome technological obsolescence by imitating the obsolete system on the current generation of technology.
[15] For instance Mobygames (2007a).
[16] One of the most famous is the arcade emulator MAME (2006), which attempts to catalogue the hardware and software of arcade games.
[17] For a fuller discussion of the issues surrounding preservation the emulation community, see chapter 4 of Gooding (2007, pp.34-44).

based preservation makes our heritage even more vulnerable, as American archives show little interest in preserving UK-specific systems such as the ZX Spectrum. Migration[18] runs the risk of corrupting the gaming experience (Herz, 1997, p.74). While emulation can provide a more faithful reproduction of the original, it takes minimal changes to interrupt the interaction between game and gamer (Hedstrom, 2007).

The games industry itself has thus far shown little interest in preserving its own heritage, although a few companies do maintain archives of their own games for internal research (Hyman, 2004). Generally, though, the industry prefers to concentrate its resources on defending itself against piracy through aggressive patenting (Boyd, 2004) and legal actions (Barton, 2005). Technological obsolescence is financially beneficial to an industry based on software and hardware sales, and companies are more focussed on new technology and software as a result (Edge, 2007, p.18). Even when classic games are re-released, they are often updated versions of the original[19], which damages their archival value. The social immaturity that the industry sometimes displays also plays a large part in damaging public opinion about games (Barton, 2005).

Finally, the cultural and political perception of games plays a vital role in deciding whether they should be preserved (Feinstein, 1997). There is, however, a deep mistrust of games in society (Johnson, 2006) which has historically been directed at many other new mediums; films (Wartella & Jennings, 2000), music and comic books (Kilgore, 1954) have all been subjected to the same treatment. The idea that entertainment products can corrupt us is not new, despite the absence of reliable supporting scientific research (Lee & Peng, 2006, p.331). Such a hostile media environment makes it difficult to secure public funding for archival effort, and the political treatment of computer games suggests little sympathy for the industry (French, 2007). The above issues are worthy of greater consideration, and have been discussed at more length in Gooding (2007).

Research Overview

Computer game criticism is a young discipline, and this is reflected in the paucity of academic resources available for consultation. Accordingly, a number of contemporary information sources, including online journals, governmental websites regarding relevant legislation, corporate websites, personal websites, Internet message boards, mailing lists, forums, Wikis, and blogs are the best sources for information about the topic, and were the sources consulted in this research.

Quantifying loss is a problem for archivists, because of difficulties in identifying lost information, such as computer games, which are currently viewed as transient objects (King and Krzywinska, 2006, p.7). This research uses online resources, archival catalogues and shared knowledge to quantify the scale of loss of computer games, with specific reference to those produced in the United Kingdom, by taking a random sample of computer game hardware, software, and documentation produced in the UK within a defined period, and establishing a best case scenario for the related computer games' current availability.

[18] Migration is 'to copy data, or convert data, from one technology to another, whether hardware or software, preserving the original characteristics of the data' (Harvey, 2005, p.147).
[19] Sony Playstation 3: network http://www.us.playstation.com/PS3/Network

The picture that this paints appears extremely bleak, as our conclusions show. However, by researching and highlighting the problem, we can find strategies for ensuring that future scholars avoid the same element of archival doubt that Derrida (1998, p.101) describes:

> We will always wonder what, in this *mal d'archive*, he may have burned. We will always wonder, sharing in compassion in this archive fever, what may have burned of his secret passions, of his correspondence, or of his "life." Burned without him, without remains and without knowledge.

Quantifying the Loss

In order to provide an overview of the current state of computer game preservation, a random sampling approach was used to give three different measures to ascertain the availability of hardware, software, and documentation. There are limitations to undertaking such a study. Documentation is scant, and some current archives are not publicly available or searchable. As a result, there is no comprehensive reliable resource on computer games: the best source available for release and cataloguing information is Wikipedia (2007a), which is neither peer-reviewed, nor a trusted source. Many websites do attempt to provide information about computer games, such as Mobygames (2007a)[20], The Video Game Critic[21], Home of The Underdogs[22], IGN[23] and Gamespot[24]. These websites show the scale and impossibility of ascertaining availability: Mobygames (2007a), which aims to catalogue all relevant information about computer games, contains more than 18,000 individual game records. However games that are rare, unrecorded or lost are naturally unlikely to be adequately documented. It would not be feasible to investigate the present availability of such a large number of games, so 50 games have been chosen to provide a large enough sample from which to draw conclusions.

To ascertain availability for procurement, figures have been taken primarily from Ebay[25], the online auction house, and include products available outside the UK. (There exists a number of specialist classic game websites (Chronic Games, 2007; Ukretro, n.d.), but in general their stock is extremely limited in scope compared to Ebay. UKretro[26], for instance, had only 26 Atari 2600 games available in total.) It is clear that relying on stock available on Ebay cannot be considered an effective preservation strategy, and even buying games for an archive could prove problematic. The products for sale are entirely reliant on sellers, and there is no real guarantee of quality when purchasing. However, it is the best way to ascertain availability of a game. When games or hardware were unavailable from Ebay, Google, Amazon, gaming websites were used to search for other available copies. Accordingly, the results give an accurate idea of games and hardware available in the three months to August 10, 2007 rather than a definitive guide to long-term availability. Despite these limitations, the results show some clear trends.

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[20] Mobygames http://www.mobygames.com
[21] The Video Game Critic http://www.videogamecritic.net
[22] The Underdogs http://www.www.the-underdogs.info
[23] IGN http://www.ign.com
[24] Gamespot http://www.gamespot.com
[25] Ebay http://www.ebay.co.uk
[26] Ukretro http://www.ukretro.co.uk

Hardware Availability

The first home gaming system was the Magnavox Odyssey, released in the U.S. in 1972 and Europe in 1974. Black and white, with no sound, it sold around 340,000 units (Wikipedia, 2007c). Due to the lack of accurate records, it is difficult to quantify how many hardware systems have since been released.[27] For this study, ten early home gaming systems, released between 1974 and 1987[28], were chosen at random, to give an indication of the present availability of once popular gaming technology as commercial availability affects impressions of genuine preservation. Between them, the consoles sold more than 150 million units during their active life. Their current availability was ascertained through asking the following questions:

1. What date was the system originally released? (All data was taken from Wikipedia (2007a), the most reliable source of this information).
2. Is the system available through existing game archives and collections? The following sources were used to establish collection holdings; Guide to the Stephen M. Cabrinety Collection (2007); Computer History Museum (2007); The Digital Game Archive[29]; UT Videogame Archive; Classic Software Preservation Project.
3. Roughly how many units were sold? This information came from Wikipedia, unless otherwise stated. In many cases it is extremely difficult to ascertain an exact figure, either because records are incomplete or because the hardware was released in a variety of iterations during its life.
4. Is it possible to purchase the system second-hand? Ebay was the primary point of reference. If a system or game was unavailable there, other sources, including Amazon and a number of second-hand gaming websites were consulted.
5. Has the hardware been successfully emulated? In most cases, a search can be done through Google to ascertain whether an emulator could be obtained to use on current systems. Due to the widespread availability of emulators, no further searching was necessary in this case.
6. Is the company that produced the system still in existence, and if so is it still producing computer hardware? This question is important, as it indicated the probability of the company itself having any sort of records of producing the particular software or hardware.

[27] Wikipedia (2007a), however, gives a good visual timeline of all the major systems released by region.
[28] While this seems an arbitrary figure, it is important because it signifies the end of the 3rd generation of home consoles, known as the 8 bit era (Herz, 1997, p.20).
[29] Digital Game Archive http://www.digitalgamearchive.org/home.php

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System	European release date	Company still in existence?	Units sold	Where available?	Price	Emulated?
Philips Videopac G7000 (Magnavox Odyssey)	1974	Philips - yes	340,000	Ebay	£30	Yes
Atari 2600	1979	Atari - yes, but not producing hardware	Roughly 40million	Cabrinety Collection Ebay	£20	Yes
BBC Micro	1981	Acorn - no	1million (The BBC Lives!, 2000)	Ebay	£15	Yes
ZX Spectrum	1982	Sinclair - still exists, but not as a computer company	Unknown	Ebay	£15	Yes
Commodore 64	1982	Commodore International - no	30million (Old-computers.com, n.d)	Cabrinety Collection Ebay	£15	Yes
Nintendo Entertainment System	1986	Nintendo - yes	60million	Cabrinety Collection Ebay	£10	Yes
Sega Master System	1987	Sega - no longer produces hardware	13million	Ebay	£10	Yes
Amiga 500	1987	Commodore International - no	950,000 (Amiga history guide, 2006)	Ebay	£15	Yes
Colecovision	American release only 1982	Coleco - no	6million	Cabrinety Collection Ebay	£50	Yes
Atari 7800	1986	Atari - yes, but not producing hardware	1million	Cabrinety Collection Ebay	£15	Yes

Table 1: The availability of hardware of ten early home gaming systems, giving a snapshot of the current availability of the consoles.

Only four of the nine systems were available in an archive, and all of those were in the Stephen M. Cabrinety Collection, which is managed by the Special Collections Department of Stanford University in America (Guide to the Stephen M. Cabrinety Collection 2006). None of the systems were archived within the United Kingdom. It was possible in all cases to obtain the original hardware from Ebay. This is not a signifier of quality, merely availability. In all cases, an emulator was freely available online, and found by a simple Google search. Only two of the companies still manufacture computer systems. Four no longer exist in their original form, and the remaining three companies no longer produce computer hardware.

All the systems are still available in some form. Less than half, though, are housed in proper archival conditions. The only archives that housed any hardware were

American, hosting American versions of the systems. This is worrying because systems released primarily for the European and British markets, such as the BBC Micro and ZX Spectrum, are entirely absent from archival holdings. It also means that most holdings are entirely in NTSC format. Computer games are released regionally, and content and hardware configuration varies by region. NTSC is the encoding standard used for US releases, and PAL is used for European releases. Many games are released in different form, or at different times, depending on the region, and the technological requirements are also different. Hardware designed for the PAL region, for example, the UK, is therefore under greater threat of disappearance.

Software Availability

Given the large possible constituency of games available, it was important to take a small sample at random to analyse their current availability. 50 games from those released for the Atari 2600 (one of the most popular systems, which sold over 25 million units during its commercial life (Classic Gaming Museum 2007), meaning it is one of the easiest to collect for) in 1982[30] were chosen at random in order to ensure no bias in choosing games based on rarity or popularity. The results therefore give a clear indication of what happens when a game is no longer commercially available, and are a best-case scenario for older games. The following questions were asked: Who, if known, was the original programmer? Is the game available through existing game archives and collections? Has the game been successfully emulated? Is the game available second-hand? How rare is the game considered to be, according to a rarity scale provided by AtariAge (2007) [31]?

Key

Game: Original game title
Creator: Original programmer or designer, if known
Rom: Is the game available as a downloadable ROM?
Archive: Is the game currently in a recognised public archive?
To Buy: Is the game available to buy from a recognised source?
Rarity: Rarity rating (see Appendix 1)

[30] Release dates were taken from The Video Game Critic (2007).
[31] The rarity rating comes from a key supplied by AtariAge (2007), a commonly applied rarity measure used by Atari game collectors and catalogues, presented in Appendix 1. This has been used extensively in the gaming community for the past few years by collectors, and as a result, is a good indicator of establishing rarity.

Game	Creator	Rom	Archive	To buy	Rarity
Berzerk	Dan Hitchins	Yes	Yes	Yes	1
ET The Extra-Terrestrial	Howard Scott Warsaw	Yes	Yes	Yes	1
Star Raiders	Carla Menisci	Yes	Yes	Yes	1
Carnival	Steve Kitchen	Yes	No	Yes	2
International Soccer	Kevin Miller	Yes	Yes	Yes	2
Journey Escape	Unknown	Yes	Yes	Yes	2
Kangaroo	Kevin Osborn	Yes	No	Yes	2
Lock N Chase	Bruce Pedersen	Yes	Yes	Yes	2
Mega Force	Doug Neubauer	Yes	No	Yes	2
Riddle of the Sphinx	Bob Smith	Yes	No	Yes	2
Star Voyager	Bob Smith	Yes	No	Yes	2
Swordquest Earthworld	Unknown	Yes	Yes	Yes	2
Vanguard	Dave Payne	Yes	Yes	Yes	2
Adventures of Tron	Hal Finney	Yes	No	Yes	3
Airlock	Unknown	Yes	Yes	Yes	3
Chopper Command	Bob Whitehead	Yes	Yes	No	3
Fire Fighter	Brad Stewart	Yes	No	Yes	3
Space Cavern	Dan Oliver	Yes	Yes	Yes	3
Worm War 1	David Lubar	Yes	Yes	Yes	3
Armor Ambush	Hal Finney	Yes	No	Yes	4
Beany Bopper	Grady Ward	Yes	No	Yes	4
Communist Mutants From Space	Stephen Landrum	Yes	No	No	4
Cosmic Creeps	Unknown	Yes	No	Yes	4
Deadly Duck	Ed Hodapp	Yes	No	Yes	4
Entombed	Jeff Corsiglia	Yes	No	Yes	4
Fantastic Voyage	David Lubar	Yes	No	No	4

Fast Food	Don Ruffcorn	Yes	No	Yes	4
Final Approach	Dan Oliver	Yes	No	No	4
Fireball	Scott Nelson	Yes	No	No	4
Flash Gordon	David Lubar	Yes	No	No	4
Front Line	Ed Temple	Yes	Yes	No	4
M.A.D.	Unknown	Yes	No	No	4
Nexar	David Lubar	Yes	No	No	4
Smurf: Rescue In Gargamel's Castle	Unknown	Yes	No	Yes	4
Suicide Mission	Stephen Landrum	Yes	Yes	Yes	4
Wabbit	Unknown	Yes	Yes	No	4
Atlantis	Dennis Koble	Yes	Yes	Yes	4
Bachelor Party	Unknown	Yes	No	No	5
Custer's Revenge	Unknown	Yes	No	Yes	5
Miner 2049er	Bill Hogue	Yes	Yes	Yes	5
Mr. Do!	Ed English	Yes	Yes	Yes	5
Pooyan	Unknown	Yes	Yes	Yes	5
Raft Rider	Unknown	Yes	No	Yes	5
Tanks But No Tanks	Unknown	Yes	No	No	5
Tax Avoiders	Todd Clark Holm	Yes	No	No	5
Marauder	Rorke Weigandt	Yes	No	No	6
Sea Hawk	Unknown	Yes	Yes	No	6
Space Master X-7	David Lubar	Yes	No	No	6
Atari Video Cube	Unknown	Yes	No	Yes	7
Combat 2	Unknown	Yes	No	No	P
Game	**Creator**	**Rom**	**Archive**	**To buy**	**Rarity**

Table 2: The current availability of 50 randomly chosen computer games released in 1982 for one of the most popular home gaming consoles, the Atari 2600.

Looking at all 50 games, 30 (60%) were not listed in a games archive and 17 (34%) were not available from Ebay. 12 (24%) were not available from either source. These are startling figures, already indicating the extent to which gaming history is not

preserved, documented, or even available for procurement.

All 50 games were available through online emulation. This widespread availability is due partly to the popularity of the Atari 2600 in the online community, evident from the large number of Atari collecting websites.[32] It is suspected that the results would show emulation to be less complete for less popular systems and games. Emulation, however, is not preservation, as discussed above.

Out of the 50 games, 19 games with a low rarity rating of 1-3 were the most commonly available. Seven (14% of the total) of those 19 were not listed in a games archive, while just one (2%) was unavailable on Ebay. All of these games were available from at least one of the two sources.

Games with a rarity value of four or more (which require some tracking down, see the AtariAge rarity key) showed much lower levels of availability. Of 31 such games out of the 50, 23 were not listed in a games archive, and 16 were unavailable on Ebay. In total, 12 were not available from either source.

Overall, Ebay proved a better source of games than the combined collections of public archives, a statistic which must cause us concern since Ebay and its sellers are making no effort to preserve the games being sold through the site. The availability of a game on Ebay makes little practical difference to its long-term preservation, and its availability on the website today makes no promise of its availability on the website tomorrow.

Due to the small sample, these figures cannot be extrapolated across all games ever produced. Factors such as a game's age, popularity, release system and rarity all influence its current availability. However, this research into the availability of games for a very popular system suggests that many games are in a threatened state. The figures for archival coverage and commercial availability showed significant levels of loss. Those games preserved in archives were exclusively American releases. Given that software releases also have regional specialisation, the European PAL standard is severely under-represented in archives. Ebay is not an effective source of preservation, and although the illegal emulation provides good coverage of games, it faces many problems, and does not represent a source of preservation.

Availability of Games Based on British Library Book Stock

To ascertain the relationship between computer games and library holdings of related documentation, 15 books were selected from the British Library Integrated Catalogue (n.d.); each related to only one specific computer game. It was then ascertained whether the game was still available, giving an insight into the differing archival treatment that games and books receive, comparing the status of 15 books on gaming directly with the status of the game that they relate to. The following questions were asked: When was the game released, and for what system? Is the game available through existing game archives and collections? Is the game still available, either commercially or second-hand? Figures were also collected for the expected cost of purchasing each game.

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[32] Examples include http://www.atariage.com/ http://www.atari.org/ http://www.atarimuseum.com/ http://www.atarilegend.com/ http://www.atariguide.com/ and http://www.atarihq.com/

Book	Author	Year	Game	System	Availability	Public access	Minimum cost
Blade II: Official guide	Farkas, Bart	2003	Blade II	XBOX and PS2	Second-hand only	None	£3.45
Diddy Kong Racing: ultimate strategy guide	Wolf, Tiberius	1997	Diddy Kong Racing	N64	Second-hand only	None	£6.50
Final Fantasy VIII: the official strategy guide		1999	Final Fantasy VII	PSX	New	None	£15.99
Inside NBA Showdown	Sandler, Corey	1993	NBA Showdown	Various	Second-hand only	None	£0.01
Jet Force Gemini official strategy guide		1999	Jet Force Gemini	N64	Second-hand only	None	£4.49
Kelly Slater's Pro Surfer: official strategy guide	Walsh, Doug	2003	Kelly Slater's Pro Surfer	Various	Second-hand only	None	£7.00
Official Battle Arena Toshinden 2 fighter's guide		1996	Battle Arena Toshinden 2	PSX	Second-hand only	None	£3.00
Official Gargoyles game guide	Wartow, Ronald	1996	Gargoyles	Sega Genesis	Rare	None	
Official Rocket Science Guide to Loadstar: the legend of Tully Bodine		1995	Loadstar: The Legend of Tully Bodine	PC	Rare	None	
Onimusha 2: samurai's	Birlew, Dan	2003	Onimusha 2: Samurai's	PS2	Second-hand only	None	£3.50

destiny: official strategy guide			destiny				
WWF War Zone	McBane, Jacob	1998	WWF War Zone	PSX and N64	Second-hand only	None	£0.01
Vagrant Story: the official strategy guide		1999	Vagrant Story	PSX	Second-hand only	None	£12.49
Supercar Street Challenge: official strategy guide	Michael Own	2001	Supercar Street Challenge	PC	New	None	£8.99
Super Mario Sunshine: official strategy guide	Bogenn, Tim	2002	Super Mario Sunshine	Gamecube	Second-hand only	None	£10.50
Star Trek Elite Force II official strategy guide		2003	Star Trek Elite Force II	PC	Second-hand only	None	£16.99

Table 3. Availability of games based on British Library book stock.

None of the games for which documentation was stored could be found listed in an archive. 13 of the games were still available, either new or second-hand from online sources. The lowest price, excluding delivery, was £0.01, and the highest was £16.99. Two of the games were unavailable from any online source, which suggests a high degree of rarity. The games in question were released in 1995 and 1996, which is surprisingly recent indeed.

Even though books on specific games are considered worthy of storing in the British Library, public institutions either have no copies of these games or are unwilling to make their holdings publicly available. The logic of this is questionable; institutions appear unwilling to invest money in preserving and making available computer games, considering books of more innate cultural value than computer games. Without the original games, however, these books will be nothing more than a historical curiosity. As Lowood (2004) points out, 'the text is never the same. The interactivity of games is the *sine qua non* of this new medium; without it computer games would lose their identity.'

Given that two of the 15 games featured in books from the British Library collection were extremely rare, we must consider why books on games are considered valuable enough to preserve, even when the games are not.

The Extent of Metadata Loss

The British Library Catalogue's lack of information reflects a wider problem. One of the most difficult elements of compiling these results was tracking down reliable

resources. For example, Wikipedia (2007b) gave the release date of *Armor Ambush*[33] as 1982, while Mobygames (2007b) quoted 1979. This underlines inherent difficulties with the evidence that is available. In many cases we are reliant on the wisdom of crowds, and the absence of primary resources compounds the impact upon accuracy. Records for even the most common games sometimes lack information on their creators: of the 50 games surveyed, it proved difficult to find information for 15 (30%) of them. As stated initially, the information on rare games is even less thorough, and this is an immense barrier for archivists. It would take considerable effort to find the rights holder for each release, especially with the large number of games companies that have ceased trading. Those gaming companies which continue to trade show little concern for documenting their own history (see above). Without the proper resources and paperwork, it is difficult to quantify the level of loss that has already occurred, precisely because the data are so incomplete. The concern is that further enquiry would show even greater rates of loss.

Conclusion

The Current Preservation Crisis

This research shows that little has been done to legally preserve computer games in the United Kingdom, and that we are rapidly losing our digital game heritage. Although there are examples of archives working to preserve games, the range of software that they have preserved and recorded in the public domain is woefully limited and few of the archives gave detailed information about their holdings. The UT Videogame Archive (2007), for instance, is finding it difficult to secure funding in order to engage an archivist. That Ebay proved a better source of old games than the combined resources of computer game archives is an indication of the serious state of current preservation levels.

The archives also preserve very few of the games produced in the United Kingdom, despite the fact that the UK is a leading player in games development. None of the archives in the U.S. contain PAL releases, and none of them are attempting to preserve British systems such as the ZX Spectrum.

Analysing software and hardware availability indicates that most preservation has been undertaken by the emuscene, which was found to have preserved 100% of the games studied. Unfortunately, legal issues mean that their work is of little archival value, at least in the short term. The games industry firmly believes that emulation causes lost revenue on its software, and the emuscene's claims that only old games are preserved are weakened by widespread software piracy (Conley, Andros, Chinai, Lipkowitz & Perez, 2004, p.8).

Strategies for Developing Preservation in the UK

As computer game preservation stands, we can no longer avoid the widespread loss of the early years of gaming artefacts. Public opinion, industry concerns with profitability, legal and technological difficulties and a lack of political impetus have all all contributed to this situation. The aim of this paper has been to analyse the current state of preservation. Further identification of the factors that have hindered

[33] Released by M-Network in 1982, *Armor Ambush* puts two players in control of tanks, which fight against each other over terrain of varying traversability.

preservation will help in developing strategies to ensure that this bleak outlook is improved (see Gooding, 2007).

The scale of this research means it is impossible to provide anything more than a snapshot of contemporary computer game preservation. It provides us with an analysis of the problems that we face in ensuring the long-term archival existence of this medium. There is no doubt, though, that further work must be done to give a firm idea of the current situation. It is essential to begin collecting and standardising computer game metadata, and this could be a valuable topic for future research. A single, accurate catalogue and games taxonomy would allow games researchers, designers and cultural historians to access a reliable, comprehensive source of information, thus ending our current reliance on publicly collated data of questionable provenance. A future project must also be to contact curators and archivists already working on game preservation, in order to gain an additional perspective on the challenges they have faced in creating and managing collections. Discussions must also take place with some of the major stakeholders: through convincing industry figures and museums of the importance of game archiving, we may be able to take steps to co-ordinate current attempts.

An understanding of the problem that preserving a vibrant yet ephemeral medium such as computer games presents is crucial in establishing archival methods. It is important to identify the steps that must be taken to prevent the history of gaming being lost. We can follow the American example in many respects, but it is important to ensure a regional co-operative approach to a problem that is only now coming to wider attention. The UK is currently worse off than other areas, but through identifying and learning from past mistakes we can ensure that computer games become an exception to the idea that preservation must come after widespread acceptance. Current technology allows us to preserve not just a record of events, but the event of play itself, and accordingly the shape of future research will be influenced by the actions we take now. Losing computer games will deprive future generations of an understanding of what makes them such a central facet of modern culture. As Derrida (1994, p.18) says, 'what is no longer archived in the same way is no longer lived in the same way.'

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Appendix 1: Rarity key (AtariAge, 2007)

The rarity key describes a numerical rating system for the availability of Atari 2600 cartridges. It was designed and implemented by AtariAge, a large website dedicated to Atari software and hardware.

#	Title	Description
1	Common	The most common of all games. These are the titles that you almost always find when you buy a stack of games at a flea market or thrift store. Any longtime collector probably has stacks of these.
2	Common+	Almost as ubiquitous as Common, but may vary slightly from collector to collector. Even beginning collectors can find almost all of these without much difficulty.
3	Scarce	Scarce cartridges are those that you don't find in every pile, but you will find them often enough. Although you may have trouble tracking down every Scarce cartridge initially, you can eventually get them all.
4	Scarce+	Getting harder to find, it may be difficult to track down all the Scarce+ cartridges if you are only hunting locally. For that reason, you may have to resort to online resources to track down all of these, although you should be able to pick them up inexpensively.
5	Rare	You don't see these everyday, unless you're really lucky. We're just getting into the rare territory, and you will probably have to do some trading or online buying to acquire all these cartridges. Expect to pay in the $10-$20 range on the collector market for these titles.
6	Rare+	Ah, now we're talking. Dedicated cartridge hunters can find these in the wild with perseverance, but it will take considerable effort. If you must resort to Ebay, expect to give up $20-$30 each.
7	Very Rare	Very rare, cartridges you will rarely run across in the wild.. You might even have a hard time finding these on Ebay, but they show up often enough that you should wait for a good deal.
8	Very Rare+	Worth bragging about if you find it in the wild. If you buy one of these on Ebay, expect to pay well for it.
9	Extremely Rare	Extremely difficult to find, although these are attainable. Even veteran collectors of many years are excited by finding one of these babies in the wild. Consider yourself lucky for any Extremely Rare+ cartridge that you find.
10	Unbelievably Rare	These games are almost impossible to find in the wild. Even collectors who have been at it for years may never run across one of these, and they often make up the showcase of an individual's collection. These rarely show up even on Ebay, and if they do there will most likely be a bidding war.
H	Homebrew	Homebrew cartridges are programs that were written after the demise of Atari. The first homebrew cartridge was Ed Federmeyer's SoundX written in 1995, and new games continue to

		be written today. Sometimes there are special limited editions of homebrews, but most of them are available in some form indefinitely.
R	Reproduction	Reproduction cartridges are newly manufactured releases of old games. Often these are reproductions of prototypes but they can also be games that were officially released.
P	Prototype	Prototypes are games that were not released commercially, and they range from demos to fully working versions. Prototypes are generally very rare, although in some cases there may be dozens floating around. Beware of fakes. This icon refers to original prototypes only, not reproductions of prototypes.
?	Undetermined	These games have not been assigned a rarity yet due to insufficient information. This does not necessarily mean that they're rare. If you'd like to help us determine rarity for these games, please feel free to participate in our Rarity Guide Forum.