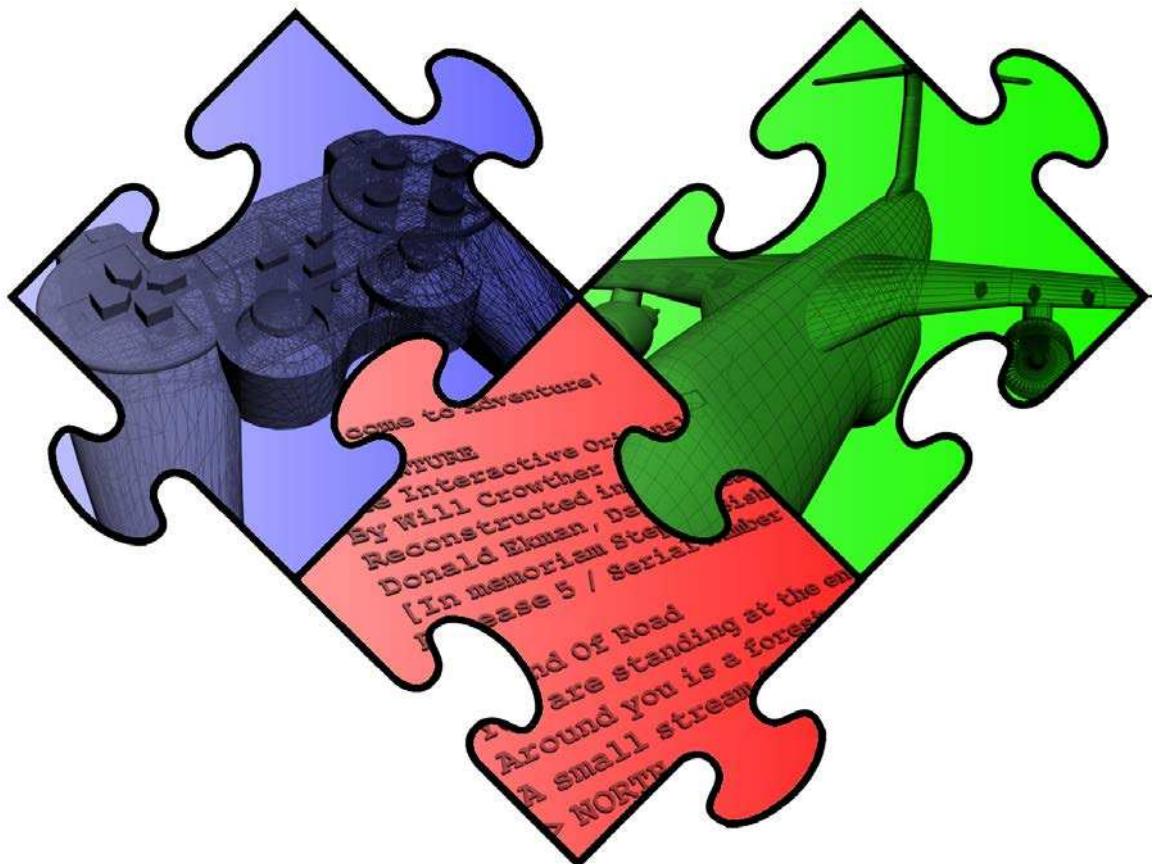


The Preservation of Complex Objects

Volume 3

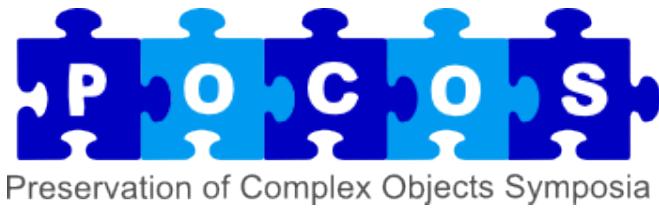
Gaming Environments and Virtual Worlds



2013

David Anderson, Janet Delve, Leo Konstantelos,
Clive Billenness, Drew Baker, Milena Dobreva

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Preservation of Complex Objects Symposia



The Preservation of Complex Objects

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Preface

Dan Pinchbeck

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I've been playing videogames since I was five years old. My parents got an analogue Binatone system with seven games on it- all variations of Pong. I was hooked instantly. I remember a couple of years later when the Atari 2600 came out, and playing Adventure for the first time. It's slightly comical now, in the era of Grand Theft Auto and Skyrim, but I clearly remember being completely awestruck by the sense of scale, the amount of world that could fit onto that cartridge. At the age of nine, I bugged my parents until they agreed I could combine all my Christmas and birthday presents from everybody for a whole year and get a ZX Spectrum 48K. And that was it: Manic Miner, Atic Atac, The Hobbit. I was a gamer for life.

We've all got those memories of discovering games. I would say they form an integral part of the lives of a generation, only that's no longer true. In reality, games now form an integral part of the lives of every generation. They are as central to our culture, our heritage, our development as individuals as television or books. This makes it all the more extraordinary that we are failing to save them.

POCOS follows on from a series of innovative and much needed initiatives that aim to do something about the current lack of serious games preservation. Digital heritage has been a major part of international cultural heritage and preservation for some years of course, but games have only really ever sat at the periphery of that. The reason, I suspect, and having worked alongside other contributors to this book over the course of several projects know I am not alone in this opinion, is largely pragmatic and partially cultural. As chapters in this book will illustrate vividly, preserving digital games is extremely difficult. Compared to videogames, ensuring that documents, images, even audiovisual material is stored and catalogued in a way that preserves access for future generations is extraordinarily challenging. Whilst memory institutions have been busy creating repositories and strategies for PDFs and JPEGs and feeling very pleased with their achievements – and rightly so – games historically have slipped through the cracks and now we are running to catch-up, trying to accelerate the solutions to games preservation to make up for the appalling lack of formal work in the past.

Culturally, games are beginning to be understood as one of the fundamental mediums of our time. Their impact on society and culture has been criminally underestimated, or shackled to tabloid-selling frenzies about negative effects, usually based on incomplete data or spurious under-supported claims. This, coupled with a sense of their disposability based on the triviality of play, has compromised preservation for many years, but it really misses the point in quite a fundamental way. Yes, games are frequently trivial, they are, ultimately, an entertainment product. But *play* itself is far from trivial, play is a cornerstone of social and individual behaviour. If imagination, and the tools by which it is fostered and encouraged are seen as having no cultural worth, then society is in serious trouble. Play may be pointless, but this pointlessness is hugely important. Escapism has an absolute worth, and the ways in which a culture entertains and distracts itself; the way its individuals play, is of huge historical value. Just as understanding history is not simply a case of checking off wars and dynasties, so culture belongs as equally to the frivolous as

the sublime. Lara Croft and City¹⁷ are as important to understanding our culture as Hamlet or Elgar.

But this isn't the place for a polemic or manifesto and would almost certainly be an exercise in preaching to the converted, so we will leave the arguments for why games need to be preserved here, assuming only, that as an intelligent reader, you need no convincing of this fact. POCOS is not a collection of essays on *why*, it's much more important than that. This is a collection about *how*.

The issues facing games preservation range from the technological to the legal, the administrative to the curatorial, and it's a strength of this book that it draws a diverse range of authors together in keeping with this diversity of challenges. It is particularly encouraging to see major figures from the commercial, public and academic sectors standing shoulder to shoulder to not only make the case for an integrated programme of preservation, but exploring practical means to achieve this together. This lack of co-ordination, communication and appreciation of the mutual benefits of such an approach have always hampered games preservation, and POCOS is important if for nothing else than clearly demonstrating what can be achieved through a proper fusion of the sectors. In this book we find chapters by academic preservationists and data specialists, a museum curator, a game developer, a librarian, a film animator and the head of a major publisher. This is an exceptional body of contributors and genuinely unusual in its scope. A hope for this book is that this proves that not only is there a requirement for cross-field collaboration but there is a genuine will for this to happen as well.

Recognition should also be paid at this point to the gaming community at large. Up until now, the overwhelming majority of games preservation has been carried out by private individuals and community groups. As more formal methods and strategies for preservation develop and become implemented, there is no question in my mind that we will rely heavily on these community initiatives to provide objects and data which would otherwise have been lost. The professional preservation sector owes them a great deal, not least of which is the commitment to establishing lasting and secure cataloguing, storage and access to this medium.

As this book demonstrates, there is much to be done. We are still grappling with the complexities of highly diverse, interwoven technologies, with how to preserve the experiential and social qualities of gaming, particularly online and multiplayer games, with the problem of IP ownership relative to often highly complex legal relationships between publishers, developers and individuals. The turn-over of software and hardware continues to accelerate, making migration an obsolete strategy but placing enormous strain on emulation as the only viable alternative. We have already made considerable progress in metadata, lobbying, strategising, dealing with the legal tangle, as the contributions to this book prove. But there is clearly still a long journey to be undertaken.

In 2007, when I was working with the POCOS organisers on the EC funded KEEP project, I put together a group of talks for the Digital Games Research Association (DIGRA) academic conference. Shortly before that, KEEP had organised a workshop at Nordic Games. In both of those cases, the presentations were excellent, but attendees were thin on the ground. The idea of game preservation, even amongst expert communities, failed to gain much interest. Earlier this year at the POCOS symposium, equally excellent presenters spoke to a packed room. We may have a long way to go, but we've already taken important steps. Ultimately, at the heart of preservation of any kind are people – the recognition that something is worth saving, the skills and the passion to undertake what is bound to be a daunting task. Perhaps the most rewarding aspect of being involved in this journey has been both watching those people at work, and seeing

the cause grow in visibility, seeing new converts and seeing sceptics convinced of the value and viability of what we are committed to. This book feels like another important part of that process and I'm delighted to welcome you to it.

Acknowledgements

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Introduction to POCOS e-Book 3: Preserving Gaming Environments and Virtual Worlds

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Background to POCOS

The preservation of complex materials and associated environments presents the Digital Preservation (DP) community in general and the JISC community in particular with considerable intellectual and logistical challenges. While many of the techniques that have been developed within the context of migration-based DP approaches are of continuing value, others cannot be applied so well given the extra complexity presented by, for example, interactive videogames. Recent work undertaken in the Planets and KEEP projects has shown that the problems involved in preserving such materials and their associated environments, while substantial, are by no means intractable, but in order to continue to make progress in this area it is important to engage and energize the wider DP community. A vital aspect of this process comprises articulating the state of the art in 1. *Simulations and Visualisations*; 2. *Software Art* and 3. *Gaming Environments and Virtual Worlds*. This encompasses exploring with international experts the research results achieved so far across each of these domains; presenting coherent pathfinder solutions; and clearly signposting areas where work remains to be done. A further step is to synthesize key findings across all three areas and emphasize synergies that can be built upon, and to disseminate these to the various stakeholder communities. These are the principal objectives that POCOS addresses and POCOS partners are well-placed to tackle the problem space, with the University of Portsmouth as overall coordinator bringing research and technical input from KEEP; the British Library supplying project management and research expertise from Planets, King's Virtualisation Laboratory bringing their specialist visualisation and simulation knowledge and experience and The Humanities Advanced Technology & Information Institute giving their specialist Software Art expertise from Planets.

So, in a series of three symposia presented across the UK:

- *Simulations and Visualisations* organized by the Kings Virtualisation Laboratory (KVL) at Kings College London on June 16th and 17th 2011;
- *Software Art* organized by The Humanities Advanced Technology & Information Institute (HATII), the University of Glasgow, at the Lighthouse, Glasgow on October 11th and 12th 2011; and
- *Gaming Environments and Virtual Worlds* organized by the Future Proof Computing Group, the University of Portsmouth at the Novotel Hotel, Cardiff on January 26th and 27th 2012;

POCOS brings together the leading researchers and practitioners in each field to present their findings, identify key unsolved problems, and map out the future research agenda for the preservation of complex digital materials and their related environments. The fundamental task to be faced during these symposia lies in presenting specialist

material of great technological, organizational and semantic complexity in a lucid, cogent, relevant and approachable manner so as to engage UK HEI researchers and practitioners in a wide variety of disciplines, as well as reaching those further afield in, for example, commerce, industry, cinema, government, games and films classification boards, and healthcare. There is also the added concern that the specialists in each field may not necessarily be aware of general trends in DP, and vice versa. Similarly any differences in terminology might need carefully addressing. Hence, clarity of expression and good communication is thus paramount throughout all the exchanges and discussions.

To this end, there is a series of three e-books, one for each symposium output plus any additional salient material, available from the POCOS website <http://www.pocos.org/index.php/publications>. There is also planned a final compendium book covering all three symposia, together with a set of pathfinder solutions. This e-book is the third of the three, and continues the discussion of complex digital objects in the context of *Gaming Environments and Virtual Worlds*.

The nature of a complex (digital) object

An essential first step when considering the nature of complex digital objects is to recognize that there are multiple layers of difficulty encountered when attempting to analyze them. These layers could be superficially likened to Georg Cantor's "levels of infinity"¹ in terms of mapping out the size of the problem space to be analyzed. The first "level of infinity" is that of detail: the problem of drilling down through many layers of technical elements, showing levels of interconnectedness both within digital objects themselves, and also with their technical environments. An example of such a challenge is that of preserving software art and video games under binary translation and virtualization carried out by (Konstantelos, 2010) under the aegis of the EC Planets project² where running interactive digital art under emulation and virtualization was examined in depth and scientific experiments conducted within the Planets Testbed environment. Similarly, preserving video games under emulation was the subject of a broad, systematic, in-depth study in the EC KEEP project³ (Pinchbeck et al, 2009) .

Analyzing and mapping such a great level of detail is not just confined to emulation, virtualization and binary translation. The migration community has responded to the task of recording each aspect of a complex digital object by developing ontologies of significant properties, and the Planets project played an important role in both conducting and disseminating this research (Dappert & Farquhar, 2009). However, significant properties under migration encompasses not only the "level of infinity" concerning detail, but also another one to do with scale. Emulation also addresses the issue of scale as in practice it necessitates mapping out the necessary hardware, software, middleware etc. that makes up the technical environment of each complex digital object. The characterisation work in Planets (Thaller 2009), and technical environment modelling activity in KEEP thus represent important aspects of the state of the art in this problem space, and have provided a firm foundation from which to develop the area. So, from this

¹ Developed at the end of the nineteenth century.

² <http://www.planets-project.eu/>

³ <http://www.keep-project.eu/ezpub2/index.php> Keeping Emulation Environments Portable (KEEP) is a medium-scale research project which started on 1 February 2009 and is co-financed by the EC's 7th Framework Programme (ICT-3-4.3 Digital libraries and technology-enhanced learning priority).

springboard, how do we start to tackle the task of analyzing the complex digital object per se?

The notion of the digital object is a mainstay of everyday life in mainstream digital preservation: indeed it is a concept that is fundamental to the way we approach this whole domain using OAIS (CCSDS, 2009), PREMIS (OCLC/RLG, 2008) etc. Now, we can categorise an object as being atomic or complex: for example Hunter and Choudhury refer to “atomic or composite mixed-media digital objects” (p4). Another antipodal reference to complex digital objects comes from Somaya Langley¹ at the National Library of Australia’s Gateway, who visited California in 2006 to study aspects of this subject area in three institutions (and incidentally came across the Media Art Notation System MANS that features in the Software Art e-book 2). But it is really possible to separate digital objects into atomic and complex?

Let us say that there is an implication that an atomic digital object is a single file, and that this is synonymous with the notion of simplicity. But is that really the case? A single pdf file is often put forward as an exemplar of such a straightforward file, but the recent pdf 2.0 version can contain embedded 3D objects, so can it really be considered as atomic and ‘simple’? So it might be a somewhat daunting task to rigidly categorize digital material past, present and future as either atomic or complex? During the symposia, the POCOS strategy was not to seek to impose definitions or standards on the proceedings, but rather to see whether any consensus emerged during the talks and breakout sessions. So given that general standpoint, how are complex objects regarded in terms of Gaming Environments and Virtual Worlds?

The nature of Gaming Environments and Virtual Worlds

First it is important to note that *Gaming Environments and Virtual Worlds* (and *Software Art*), are each cognate disciplines in their own right: *Gaming Environments and Virtual Worlds* have their own games developers, games museums, conferences for the gaming community, fan websites etc. (*Software Art* has dedicated artists, museums, techniques and commissioning procedures. But *Simulations and Visualisations*, on the other hand, are in a somewhat different category, comprising as they do amorphous techniques / outputs that are used in many different fields.) What then are the special issues facing the preservation of *Gaming Environments and Virtual Worlds*?

Only very recently have games been officially recognized as part of our cultural heritage, so up to now there have not been the official links in place between memory institutions and gaming communities. Thankfully this is changing, and more and more national libraries are starting to archive games / virtual worlds. For example, the British Library holds games collections in its personal digital archives, and the Royal Library, Copenhagen, Denmark, has a sizeable games collection. Representatives from both these institutions were present at the third POCOS event. Previously the only groups leading games preservation were the games fans and developers themselves (the French National Library being a significant exception here).

Particular problems revolve around IPR issues that leave some games “orphaned”, with no-one knowing who owns them and thus how they can legally be preserved. IPR is even more difficult for virtual worlds where permission is needed from the users to preserve their avatars. Not surprisingly, this is not readily forthcoming, and so at best, it is only

¹ <http://www.nla.gov.au/pub/gateways/issues/84/story05.html>

possible to preserve incomplete virtual worlds. Another pressing topic is the technical complexity of the games and virtual worlds and their attendant environments. Saving the many parts of these games (mods, cracks etc.), plus details of their computing environments so that they can be emulated or virtualized in future, poses a significant challenge. The founding of the dedicated New Media Museum, UK has been a real boon in this respect, with their games environments and associated material. Similarly for the Computer Games Museum at Berlin, Germany which allows access to old games via the KEEP Emulation Framework.

The book contents

Dr Dan Pinchbeck of thechineseroom is a leader in games preservation as well as being an award-winning games developer for Dear Esther. In his other life as Reader in Computer Games at the University of Portsmouth, Dan played a large part in shaping the *Gaming Environments and Virtual Worlds* symposium. In “Standing on the shoulders of heavily armed giants: why history matters for game development”, he traces the history of first person shooter games and highlights why games history is important for games developers. He then draws attention to the main problems facing games preservation today.

In “A Tangled Web: Metadata and Problems in Games Preservation”, Professor Jerome McDonough of the iSchool Illinois, USA, then explores the unique challenges that games preservation presents as identified by the “Preserving Virtual Worlds” team from their work on metadata and OWL ontologies. Angela Dappert of the Digital Preservation Coalition / TIMBUS project continues the metadata challenges theme in her “Metadata for Preserving Computing Environments” where she takes a broader look at metadata needed for preserving business environments, including the games industry. In “Preserving Games Environments via TOTEM, KEEP and Bletchley Park”, Janet Delve of the University of Portsmouth Future Proof Computing Group discusses the recent TOTEM technical registry work carried out in the KEEP project. She outlines how TOTEM can be accessed to ascertain computing environment metadata for PC games and games consoles, and how the KEEP Emulation Framework is being deployed at the Computer Games Museum, Berlin, to run old games via emulation. She draws attention to the wealth of computing environment material available at computer history museums worldwide, and calls for closer collaboration with colleagues from this domain.

In “Archaeology versus Anthropology: What can Truly be Preserved?” Professor Richard Bartle of the University of Essex examines the real difficulties of preserving virtual world inhabitants as opposed to their environments, and emphasizes the need to gather these social aspects of the data right now. In “Preserving Games for Museum Collections and Public Display: The National Videogame Archive”, Tom Woolley, curator of New Media at the National Media Museum, UK describes the scope, current work, holdings and access policy of the National Videogames Archive (NVA), and reflects on proven solutions and plans for overcoming the challenges surrounding videogame preservation and display in the future. In “A National Library Perspective On The Preservation Of Games” Paul Wheatley of the British Library discusses collaborative ways forward for both the library and the wider games community in tackling games preservation, and outlines a number of initiatives being undertaken to move towards this.

Ian Livingstone OBE, Co-founder the Games Workshop, Life President of EIDOS, and founding father of the UK’s interactive games industry, takes us on a tour of the “Future

History of Video Games” from his unique perspective. Paul Charisse is currently a Senior Lecturer in Animation at the University of Portsmouth, having worked on animation for “Harry Potter” and as part of the animation team behind Gollum in the “Lord of the Rings”. In “Archiving software and content in Visual Film Effects: An insider’s perspective” he gives us a glimpse of the difficulties peculiar to preserving animations in the film industry. Finally, the “Computer Games and Virtual Worlds Preservation: Challenges and Strategies” chapter presents the findings from the symposium break-out sessions.

The glossary appears at the end of the book to guide the unwary gamer / WoW fan or DP traveller through the minefield of acronyms...

We hope these research findings will help to stimulate debate on these topics, and look forward to continuing along this rich vein of research.

Links to the other books in the POCOS series

The first e-book is on *Preserving Visualisations and Simulations* and involves some current issues such as preserving 3D models as well as hybrid digital objects in an archeological context. The second e-book is on *Software Art*. Details are available on the website <http://www.pocos.org/index.php/publications>

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Standing on the shoulders of heavily armed giants – why history matters for game development

Dan Pinchbeck

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Abstract

I examine the evolution of first-person shooter and role-playing games and consider how over the past 30 years the two genres have influenced one another. I trace their development from initial mainframe-based games, through their growth into multi-player versions and finally the creation of immersive virtual reality environments encountered in current products, highlighting key moments in their evolution. I consider the motivations from the position of different people with an interest in computer games for seeking to preserve them in view of their cultural significance. Finally, I identify the weaknesses in the current arrangements for preservation and advocate a more structured approach in the future.

Introduction

When I was invited to attend POCOS, my brief was to speak from a developer's perspective rather than that of an academic. I should explain, however, that I started out as a member of an academic research team considering matters relating to games history. Initially we focused on games history and trying to identify games design spaces which were not being exploited by the games industry.

In our role as academics, we were able to use research programmes to explore these topics, without the pressure that the games industry is normally under to produce a commercially successful game. Researchers have a greater ability to push the boundaries of design as they have different objectives, and the production of 'interesting' data would still be considered a successful outcome. Fortunately, however, the game which we produced 'Dear Esther' (DE)¹ also achieved praise from the games community leading on to a commercial release.

¹ <http://dear-esther.com/>

Figure 1: Dear Esther¹

My topic here is to consider why games history and preservation are of great importance to contemporary games developers and what I, as a developer, would like to become available.

When DE was released, it received a high score from Edge, but I noted one interesting comment from a reviewer who said that “Piece by piece Dear Esther makes you forget all you have learned about games and reminds you of a time when genres were still young”.

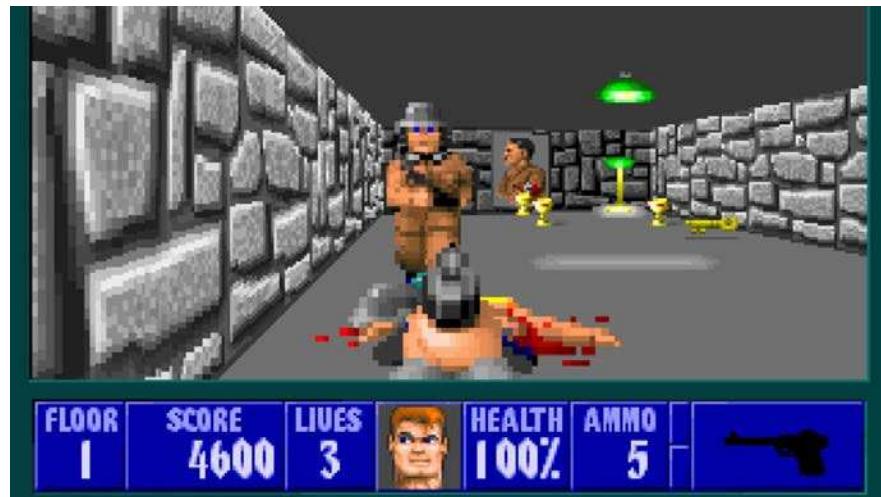
A First Person Shooter Perspective

This is interesting in the context of DE which is a first-person game in which there is a direct perceptual mapping between the player and the avatar, and the player sees through the avatar’s eyes, with no character on screen. This is a genre of game which is most associated with combat-style games involving (usually gun-) battles with various types of hostile creature within a labyrinth. Examples of this would include Doom² and Wolfenstein³. It was here that the template for what first-person gaming could be like was first defined.

¹ <http://thebitfix.com/wp-content/uploads/2012/02/dear-esther-review.jpg?e393c2>

² <http://www.idsoftware.com/games/doom/doom-final>

³ <http://www.idsoftware.com/games/wolfenstein/wolf3d/>

Figure 2: Wolfenstein 3D¹

I would like to consider the history of how first-person games have developed. A debate has arisen about whether DE is an ‘art game’ or a logical extension of first-person shooter games. We, as the authors, have always seen DE as a natural progression from the original first-person shooter games, even though it does not have weapons, gameplay, action or a story. To understand the lineage and evolutionary history of how these games have developed is important for achieving an understanding of the future development path of these types of game.

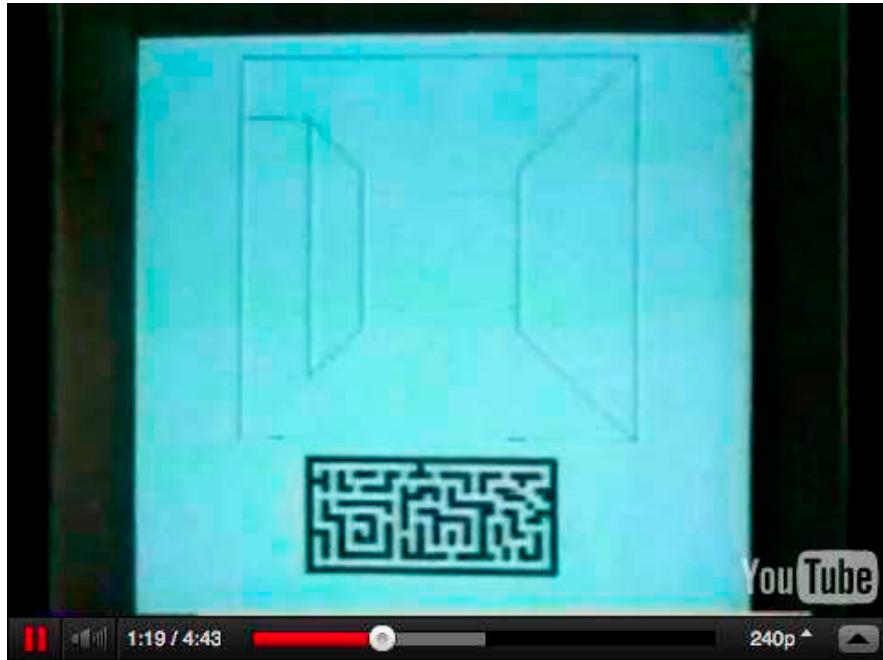
As a developer, understanding of games history is also commercially important, because understanding what has proven successful (and unsuccessful) in the past will assist in future development. However radical an approach a new game might take, many of the core design challenges were defined – and solved – early in the evolution of the genre.

The earliest first-person shooter computer game was ‘Maze War’², developed by Steve Colley and first released in 1973 and all the elements of contemporary first-person games can be found there, at the very outset of the genre.

The game has a simple wire-frame maze which operates in a single horizontal plane in which players interact and shoot one another. All first-person (and also third-person) games have their genesis here. And interestingly this game became multi-user almost immediately, running peer-to-peer first via serial ports and then shortly afterwards over a network. Given the strength of multi-player gaming worldwide, one can see that the concept of multiple players interacting across a network was already present in Maze War right at the outset of computer games. Curiously, interest in this multiple-player aspect of gaming tailed off for a long time and games were reduced to being single-player again, both in early arcade games and consoles. Nevertheless, the core principle was established at the beginning that with first-person shooter games, players would play with each other.

¹ <http://thetechblock.com/wp-content/uploads/2012/05/wolfenstein3d.jpeg>

² Maze War on Xerox Alto—YouTube: www.youtube.com/watch?v=7chDIySXK2Q

Figure 3: Maze War on the Xerox Alto¹

When one considers analogies in other types of design, for example any kind of simple household object, even when the object diversifies or new functionality is added, by tracing back to the core function, one can still understand something about how the object was developed and what its constraints are. The same is true for games. The fact that the original design was for one-to-one or one-to-many gaming, and not just a lone human player versus a computer is really important to what one understands about the game. The whole environment is designed to create uncertainty, as the player has limited knowledge and does not know what they will confront next. The key principle is *immediacy* and this is essential to the gaming experience.

A more popular perception of the foundation of the genre of first person shooter games is that it began with ‘Doom’ in 1993. This game is very similar in nature to Maze War. While the graphical appearance of the environment and the avatars is far more sophisticated than Maze War, the gameplay appears almost identical. The game is not, however, identical to Doom, which is, in fact, a remake of a side-scrolling 1982 stealth game called ‘Castle Wolfenstein’ where the player tried to escape by hiding and moving bodies out of the way, but not shooting very much. This game had turned into ‘Wolfenstein’ in 1992, which was written prior to ‘Doom’, and in which the authors sought to recreate the game experience of Maze Wars, but with added excitement provided by the addition of Adolf Hitler as a character, along with large guns and other violent accoutrements.

¹ <http://www.youtube.com/watch?v=7chDIySXK2Q>

Figure 4: Doom¹

An emotional framework

Doom depended on state-of-the art technological knowledge, which the authors attempted to combine with classic 1970s arcade games. When I recently interviewed John Carmack (co-founder of id Software), he said of himself and the writing team:

“We were not innovators, we were vandals. We looked at what academics were doing with virtual reality and simulation and it was really beautiful, but it was also really slow. We said ‘let’s just rip the guts out of it and make it run really, really fast’. So we vandalized academic simulation research to get something which ran as fast as Space Invaders”

Thus technology provided an emotional framework for a human experience.

Doom is also significant because although the storyline is very simple (demons from Hell invade a space station), it has very significant content. The authors established a design principle that everything in the game existed purely to support gameplay. Thus the demons do not possess artificial intelligence, they simply charge and attack. There are no complex puzzles to solve in Doom, the player simply moves around the game shooting at things. Thus, the content was pared down to enable the gameplay, while the story meshed and supported the emotional content of the game. Doom also demonstrated that if the sophistication of the content is increased, it reduces proportionately the space available for the player to occupy. Many similar games followed Doom, but they are all almost identical apart from higher graphical resolution.

¹ http://images4.wikia.nocookie.net/_cb20080630083509/doom/images/4/4b/Doom-1-.gif



Figure 5: Doom with better graphics? Call of Duty¹

Interestingly this genre misses the 1980s almost entirely. During that decade, most of the first-person games were role-playing games involving command structures and far slower play. As a result, the emotional intensity of the game-playing experience is different, although game designers recognized that within the notion of first-person play there was ‘something’ which they wished to retain and use. And at the core of the development of the first-person game was the unique experience given to the player when the perception of the avatar is mapped to their own.

The emotional experience is changed when a game is perceived through the senses of the avatar. There is a sense of immediacy, and the gameplay is highly immersive. The game designer can foreshorten the player’s natural sense of perception so they are unable to predict what will occur next, thereby heightening tension. First-person games lend themselves to tension like no other gaming medium. These games can also contain enormous drama of scale, with play moving from narrow corridors to immense vistas and back again. Although early role-playing games were very slow and often also very static, what was understood was the unique emotional relationship between the player and the world that this genre of game creates.

FPS/RPG Crossovers

Moving into the late 1990s, role-playing games fell into the background for a while until a new set of titles appeared, from which we began to understand the success achieved in Doom from capitalizing on the immediacy of the action and the emotional journey which the player experienced. These new titles also considered what had been lost through the simplification of the playing experience in games like Doom, and whether it was possible to recombine the ‘configurative’ activities from role-playing games in order to exploit the strengths of two different genres of game and create a new, third one.

¹ http://www.hollywoodreporter.com/sites/default/files/2010/11/call_of_duty_bopps_2010_a_1.jpg

This led to the birth of what are referred to as ‘FPS/RPG Crossovers’, which continue to develop the relationship of the player with the world. There remain elements of arcade game play and configurative game play. The power of these games comes not from the game play itself (which is almost indistinguishable from the 1980s’ games) but rather from the scale and depth of the world which these offer. An excellent example of this scale and depth is to be found in ‘Skyrim’¹.

It is difficult to decide whether to link Skyrim to role-playing games or to games like Doom. Even though Skyrim is a fantasy, role-playing game, the violence has been muted. The player does carry a weapon, but is not constantly confronted by opponents to kill arcade-style. Instead, the game presents the player with a huge world to explore and to ‘be’ in. The gameplay is associated with the ability to travel around a beautifully-rendered world where the player can immerse themselves in the ‘atmosphere’ of the game.



Figure 6: Gaming on a grand scale - Skyrim²

This concept of ‘soaking up the atmosphere’ is ubiquitous in this genre, dating right back to Maze War. It is much a part of the experience of playing the game to have an emotional reaction to the world of the game as to occupy oneself with pressing buttons on controller repeatedly. In this genre, one sees instead a refinement of the concept of ‘being in the world’. It is here that games and virtual reality have the greatest degree of crossover between academic and commercial approaches. There is the capacity to insert a player into an artificial environment and for them to have some form of complex emotional experience within it.

This is true even of games which seek to re-introduce more elements of arcade games. There is one particular game which attracted huge criticism in relation to aspects of its game play (e.g. unrealistic combat capabilities, flawed artificial intelligence algorithms, poor plot) but still received positive comments for the overall environment in which it is executed. These criticisms are frequently encountered in first-person games, yet equally often it is observed that the relationship between the player’s avatar and the game environment overcomes these apparent weaknesses.

1 <http://www.elderscrolls.com/skyrim/>

2 <http://images5.fanpop.com/image/photos/27700000/Skyrim-Wallpapers-elder-scrolls-v-skyrim-27742126-1680-1050.jpg>

The Birth of Contemporary First-Person Games

One game which might be described as “The Birth of Contemporary First-Person Games” is “Half Life”¹. It represents a generational shift from Doom. Although much of the game-play is familiar from predecessor games, “Half Life” reflects a greater focus than before on creating a deeper relationship between the



Figure 7: Half-Life²

player and their environment. “Cut scenes”, which link action scenes together, were discarded. Instead, while playing the game, generated characters within the game interact with the player. This enables the player to engage with the story if they wish to. Additional minor details are added to game environment to more closely reflect the way humans acquire information about the world around them. Examples of this are a passenger missing a tram and a vending machine failing to dispense drinks. This approach is more engaging for the player.

While technology was insufficiently advanced for this to be implemented in Doom, this new approach reflects an evolution in the sophistication of design. Awareness of this kind of sophistication is often disregarded outside the community of games designers and specialists when discussing games. These aspects are, however, fundamental to the consideration of the evolution of games. They represent a quantum leap in the conceptualization of this genre of games.

One also sees games designers beginning to re-imagine and re-enact traditional literature. One example of this is “Far Cry 2”³ which is a re-imagining of Joseph Conrad’s novella “Heart of Darkness”.

1 <http://planethalflife.gamespy.com/hl/>

2 http://www.designgonewild.com/img/content_1/half-life.jpg

3 <http://www.ubi.com/US/Games/Info.aspx?pId=5925>

Figure 8: High Culture in Games - Far Cry 2¹

High culture reference points are being introduced into these games, which permits a new level of discussion about the content of a game which might otherwise be dismissed as simple, relatively mindless entertainment. In games such as this, literature combines with arcade game play. This approach also makes complex philosophical ideas more accessible. Young teenagers are now being exposed to the works of such great authors as Conrad, Strugatsky, Tokovsky and Ann Rand. There is no other medium in which this can occur and marks a great achievement by gaming. Considering the game “BioShock”², it was lauded not for gameplay so much as for the absolute simulation of the environment in which it is played.

Figure 9: Bioshock³

Pushing the boundaries - thechineseroom

It was at this point that my company created Dear Esther (DE). Although nominated for international games awards, DE has removed elements formerly considered essential to first-person gaming. It is observable that while first person gameplay has seen some refinement and modification over time, the major sophistication that has occurred over the years is that of the relationship between the player and their

1 <http://vgfaq.com/wp-content/uploads/2012/02/Far-Cry-2-Cheats-and-Trainers.jpg>

2 <http://www.2kgames.com/bioshock/uk/>

3 <http://media.filmschoolrejects.com/images/bioshock-header.jpg>

environment. At issue is the significance of the immediacy of experience within a simulated environment. Most of this development path was established as far back as the 1980s or even the 1970s with Maze War. The core principles of earlier games like Maze War and Doom can still be recognized in modern games, albeit their application now differs. Modern games are a logical extension of the history of this genre.

It may appear that these historical issues are only of academic interest. They are, however, very important to games developers. Contemporary games designers wish to trace the roots of elements they are introducing into their new games.

Their concerns are twofold:

- Historically does this element work in game play ? and
- Is this purely plagiarism of some else's game ?

Compared to many other forms of media, game players are phenomenally literate about their subject to an extent which greatly exceeds that of film and book enthusiasts. Games players have a high degree of awareness and understanding of the technology which enables their experience. Claims by games developers to have innovated in a specific area of play are liable to rapid challenge from within this expert community.

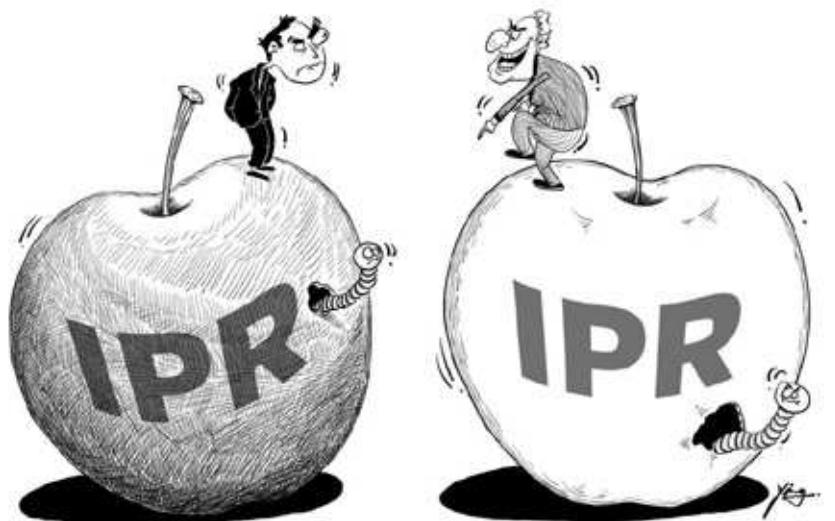


Figure 10: China Daily Cartoon on the theme of IPR¹

Aside from Intellectual Property considerations when designing a game which might exploit others' approaches, there are issues both of personal professional pride and reputational impact if similarities are identified. It is therefore important for authors to be aware of their games history not only to seek evidence of prior success of an approach, but also to check whether another author has already written something identical. Today's authors are keen to learn from their predecessors – to stand on the shoulders of giants (heavily armed or not). It is therefore critically important to have access to the history of games.

In addition, from a teaching perspective, it is not that students are not aware of the history of games, but rather that it is very difficult to gain access to this material. For

¹ http://www.chinadaily.com.cn/bizchina/2010-12/06/content_11648690.htm

example, the history of first-person shooter games and that of role-playing games are fundamentally linked. It is likely that first-person shooter games owe more to role-playing games than to arcade games. If, therefore, students intend to evolve those genres further, they need to possess a good understanding of the history. This history is, however, hard to access. This is partly because of weaknesses in games preservation.



Figure 11: Home of the Underdogs website¹

Firstly, **games preservation is illegal**. There is therefore no formal games preservation, and we are instead reliant on private collectors, by ‘abandonware’ or simply pirated copies of games running under emulation which may or may not be legal. It is thus hard for an educator to advise their students to study a particular game when this might involve them participating in illegal acts and breach of copyright. This may be the only source, however.

Similarly, games developers are at similar risk if they wish to reference historic material when creating a new game. This contrasts harshly with the situation with books and films, which remain easily accessible. Risks of criminal or civil liability arising from the improper access to historic games material can be a substantial source of concern to games publishers and distributors and so may inhibit commercial development.

Another consideration for the developer is not simply the content of the game but also the underlying technology. An example of this is the id Tech engine used to create Doom. This is an Open-GL based program which works well on mobile devices and is an excellent development platform. As a developer I might ask myself about its suitability in a project I was considering. In order to make a decision, I require a detailed understanding about how this engine (or any other engine) works. I need to understand clearly the hardware and software environments in which they work(ed). In many early games, both aspects were addressed by the developer, in order to create a development

¹ <http://HomeOfTheUnderdogs.net/game.php?id=1051>

environment. It is therefore important to preserve all this data as well as the engine itself. Preservation of the games experience is not sufficient. It is necessary to preserve the entire platform which enabled the experience.

One valuable source of information is old computer magazines and the reviews of games which they contain. These enable the developer to gauge their success. Pure digitization of magazines not only creates further copyright problems when it is done by enthusiasts, but also creates a piecemeal collection of information.



Figure 12: The National Videogame Museum¹

Leadership

There is a need for leadership. There needs to be an alternative to this community-led, semi-legal preservation. Without this community-led approach, the situation today would be dire, with little or no preservation of games material. Institutions like the National Video Game Archive are working very hard in this area of preservation.

I also think that the case is already made that computer games should be preserved as cultural objects. They are items of cultural worth. They are no less part of our cultural heritage than cartoons. Computer games are played by millions of people, and they make a considerable contribution to the economy. No individual should determine cultural worth by themselves. Worth can only be assessed with the hindsight from 100 years hence.

¹ <http://www.nationalmediamuseum.org.uk/AboutUs>

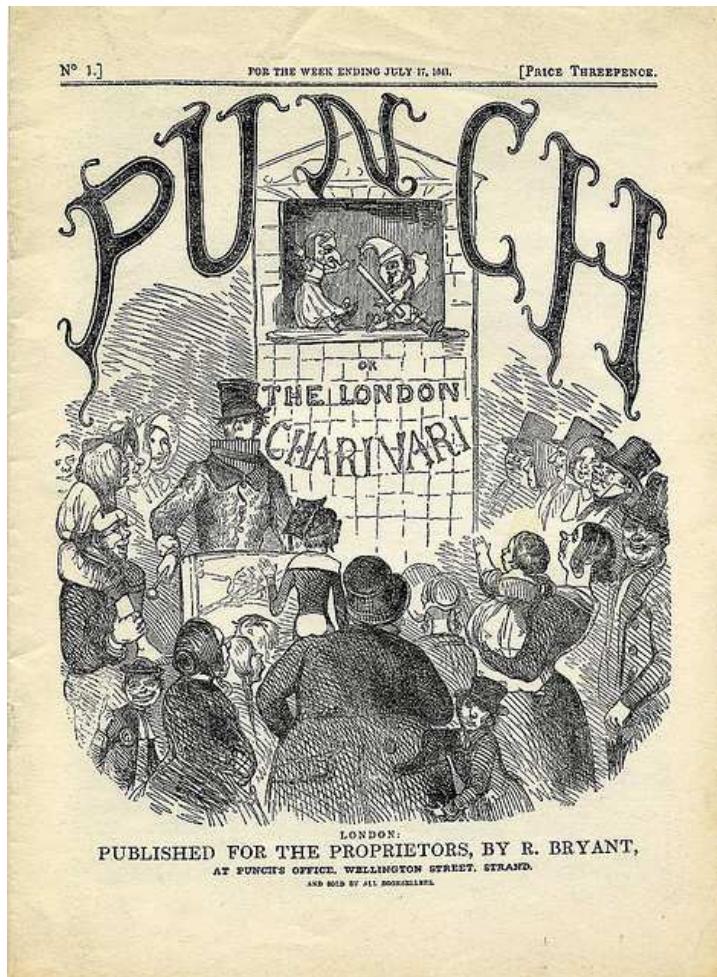


Figure 13: Cartoons of archival significance¹

The more important issue to be considered is how almost three decades of cultural material has become endangered owing to the lack of formal preservation structures, to the extent that what preservation activities which are taking place are frequently illegal.

This demonstrates the importance of initiatives like the POCOS symposia. In my multiple roles of game player, game developer and academic, I have a need to be able to access games history, to be able to play games dating back to the 1970s, to understand what techniques and approaches worked and also how the build tools worked. Finally, there is a natural human curiosity to understand how things work, and if this curiosity is shared by only a small percentage of gamers in the World, this is a need common to a very large number of individuals.

Therefore, if preservation is to be applied to different types of object on the basis that there is an identified audience for this material, then there are likely to be many games enthusiasts who will be grateful if they are not compelled to engage in potentially illegal preservation practices in order to engage with their medium.

¹ http://farm1.staticflickr.com/161/330817301_80cd457b7c_z.jpg



Figure 14: thechineseroom at the TIGA awards¹

Acknowledgments

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¹ <http://awards.tiga.org/>

The Future History of Video Games

Ian Livingstone CBE* in conversation with David Anderson**

*co-founder Games Workshop and Life President, Eidos

**University of Portsmouth, Future Proof Computing Group

Introduction

Ian Livingstone is one of the founding fathers of the UK games industry. He co-founded the iconic games company Games Workshop in 1975, launching Dungeons & Dragons in Europe, and the Games Workshop retail chain. With Steve Jackson, he co-created the Fighting Fantasy gamebook series in 1982, which has sold over 17 million copies to date.

He designed Eureka, the first computer game published by Domark in 1984, and joined the company in 1992 as a major investor and director, overseeing a merger that created Eidos Interactive in 1995, where he served as Executive Chairman until 2002. At Eidos he was instrumental in securing some of the company's major franchises including Lara Croft: Tomb Raider.

Today he is Life President of Eidos, Vice Chair of UKIE, Chair of Playdemic, Chair of Playmob, Chair of Skillset's Video Games Council, Chair Next Gen Skills Committee, Member of the Creative Industries Council, Trustee of GamesAid and an advisor to the British Council.

How did you first meet Steve Jackson and John Peake?

We met at Altrincham Grammar School in the 1960s. Steve and I used to enjoy playing board games even back then. After leaving school, we all went our separate ways, but met up again in the early seventies, and shared a flat together in London. We were working for different companies and, trying to save our meagre wages, we stayed in a lot and played board games. The one we played most was The Warlord, a little-known classic produced privately by Sheffield University lecturer Mike Hayes, and a game which Steve had discovered whilst at Keele University. As for other British games, there was Kingmaker, but mostly we were disenchanted with the ones that were available in the shops with most being traditional family games. By contrast, there were plenty of interesting American war-games published by Avalon Hill and SPI that were being imported in very small numbers by one or two specialist distributors – games like Diplomacy, Africa Korps and Stalingrad.

At that time, Steve, John and I often talked about turning our passion for playing games into a business of making them. Even though we didn't have a business plan, we decided in early 1975 to start our own company, which we called Games Workshop. John was a civil engineer by profession, but he was also a skilled craftsman, so we started off by making traditional wooden games such as Go boards, Mancala boards and Backgammon boards. Those early hand-crafted games were the main reason why we called the company Games Workshop. We were making them in our flat. It was pretty messy – sawdust and wood shavings everywhere! My role in the fledgling business was

to go out and sell the games to retailers, and Steve had responsibility for all the administration.

At what point did you decide to produce your own games?

Whilst John enjoyed making wooden board games, Steve and I weren't really happy with the direction the business was going because we were effectively doing what everyone else was doing. Our ambition was to make games that we wanted to play ourselves, but we didn't have the resources or the know-how to do it. We felt we needed to reach out to the wider gaming community to tell people about our new venture and our desire to become a specialist strategy games company.

So we set about producing our own fanzine, Owl & Weasel. The first issue was published in February 1975 and we posted it out free to everybody we knew in games. Our big breakthrough came indirectly as a result of this mail-out. Unknown to us, a copy had found its way via a third party into the hands of a gentleman in Lake Geneva, Wisconsin called Gary Gygax¹. Working with Dave Arneson², Gygax had recently invented a game called Dungeons & Dragons. He wrote to us saying that he enjoyed reading Owl & Weasel and enclosed a copy of Dungeons & Dragons.

We'd heard of it, but knew little about it. There wasn't a board inside the box, rather three fairly unintelligible rulebooks that were more of a design-a-game kit than a game in itself. It was our first experience of a fantasy role-playing game. It demanded a considerable amount of preparation to play. One person had to volunteer to be the Dungeon Master and design a dungeon on graph paper, populating it with monsters and treasure. The other players had to create their alter egos for the game by rolling dice for certain attributes like Strength, Dexterity and Charisma to determine their character class and abilities. Then by conversation, the players as Fighters, Magic Users, Thieves and Clerics would explore the Dungeon Master's dungeons, gaining experience points by fighting monsters and finding treasure. The rules and dice were used to determine success or failure based on probability of an action taking place. So whilst the box looked plain and uninspiring, the game itself opened up worlds of the imagination like no other game had done before it.

Steve and I became obsessed by Dungeons & Dragons. John didn't like it at all. Steve and I wanted to import it. John wanted to carry on making traditional wooden games, and ultimately that would result in him deciding to leave Games Workshop. Steve and I were committed to taking Games Workshop in a new direction. We wrote to Gygax and ordered six copies of Dungeons & Dragons. Gygax wrote back, thanking us for our



Figure 15: Owl & Weasel First Edition

¹ Ernest Gary Gygax (July 27, 1938 – March 4, 2008)

² David Lance "Dave" Arneson (October 1, 1947 – April 7, 2009)

order, and it wasn't too long before Games Workshop had a three year exclusive distribution agreement for Dungeons & Dragons - for Europe! Gygax was running TSR, and had gambled on printing 1,000 copies of Dungeons & Dragons (D&D), which was risky given the size of the company at the time. He welcomed the opportunity to export the game to Europe, albeit to a tiny UK mail order company operating out of a flat in Shepherds Bush. This illustrates fairly accurately the size of the hobby games industry in the mid-seventies; a fledgling industry finding its way by whatever means. We got on brilliantly with Gygax as we were all like-minded gamers learning the business together. Little did we know how important that distribution agreement was to be for Games Workshop.

What were the early days like at Games Workshop?

For the first year, we were operating out of our third floor flat selling D&D and accessories by mail order through Owl & Weasel. We also managed to sell D&D to the few specialist games shops that existed at the time such as Just Games and Knight Games in London. We also attended small model and hobby shows around the country in an effort to promote D&D. However, as we had called our company 'Games Workshop' people assumed we had our own retail store. With copies of Owl & Weasel clutched in their hands, we used to see people milling around outside on the street below looking for this imaginary shop. We would open the window and shout, "If you are you looking for Games Workshop, it's up here mate. I'll come down and let you in!" They would buy whatever they could from our limited stocks and usually leave happy. We had no phone in the flat, and had to share the use of a public payphone on the ground floor with our landlord. All our telephone orders used to come through that one phone, which of course irritated the landlord who lived on the ground floor and was constantly taking phone calls for us, not always graciously! He eventually grew tired of the calls for Games Workshop, and even more tired of the people and the parcels constantly arriving. Not surprisingly, he asked us to leave. All our profit was being reinvested in stock and we didn't have the funds for what was now needed - a new flat and an office.

It was June 1976 and with nowhere to live, Steve and I decided to go to the USA to attend TSR's GenCon convention to meet Gary Gygax and hopefully sign up the UK distribution rights for all the fledgling games companies we were hearing about. We made an adventure of it, driving to Lake Geneva, Wisconsin via New York, Los Angeles, San Francisco and Chicago! We'd stored all our stock, such as it was, in my girlfriend's flat and took off. Games Workshop closed temporarily for three months, but it was certainly worth it.



Figure 16: Ian Livingstone & Steve Jackson in USA

We had an amazing time when we finally got to GenCon. Gary Gygax was a fantastic host and really looked after us. We felt we were in incredible company as this Figure 2 (above) shows. On the far left is Fritz Leiber¹ the famous science fiction author, next to him is Gary Gygax, then Professor M.A.R. Barker² who invented “Empire of the Petal Throne”, then me looking like a hippy, and Rob Kuntz who worked with Gary on D&D. Steve is crouched down at the front looking stern! While we were there, we set about signing all the new role-playing games companies and gaming accessories companies like Judge’s Guild³, Fantasy Games Unlimited⁴ and Chaosium⁵. We wanted to import virtually every product we saw at the show, and wrote orders like there was no tomorrow. When we returned to London, we knew that plenty of games would soon be arriving from the USA, but we didn’t have an office or even a flat to operate from!

How did Games Workshop grow?

It was virtually impossible to raise finance for games companies back in those days, especially for a small hobby games company. We would go into banks to enquire about getting a loan to finance our office requirements. The bank manager would look at us with an expression reminiscent of an Alsatian dog watching television, and would usher us quickly out the door on hearing about our business plans. We couldn’t understand why the banks didn’t want to help us. We failed to get a loan, which resulted in us having to make a choice between having somewhere to live and having an office. But it wasn’t really a choice! We had to have an office. After a lot of traipsing around West London,

¹ Fritz Reuter Leiber, Jr. (December 24, 1910 – September 5, 1992)

² Muhammad Abd-al-Rahman Barker (born Phillip Barker,[2] November 3, 1929 – March 16, 2012)

³ <http://judgesguild.com/>

⁴ <http://www.fantasygamesunlimited.net/>

⁵ <http://www.chaosium.com/>

we were able to rent a spare room at the back of an Estate Agent which hardly big enough to swing a cat in. At least it had its own entrance and we operated our mail order business out of this tiny new office. When a customer arrived, one of us had to go outside! With no

spare cash, we were obliged to live in Steve's van, which was known affectionately as 'Van Morrison'. Winter was coming and we ended up living in the van for three months which was parked outside the office. It was, however, conveniently located next to the local squash club which we joined so we could have a shave, shower, etc when we emerged from Van Morrison in the morning. We got pretty good at squash by default!

During this period, we lived a small, triangular life. Up early and out

of the van, into the squash club for a shave, shower and a good game of squash, work all day in the mail order

office till midnight, then back into the cold, damp van. But it didn't seem like hardship at the time because we were doing what we wanted to do. By early 1977 we were at last able to afford to rent a flat, albeit a very grubby one in Shepherds Bush.

A year went by and the business grew, but not as quickly as we wanted it to. We tried to sell D&D into other shops. The specialist games and hobby shops dabbled in it, but despite our efforts, we met with a lot of resistance. Retailers had trouble understanding how to retail D&D and all its accessories. There was a lot of consumer interest in D&D and we were frustrated by retailers' reluctance to stock it. In the end we had no choice but to open our own shop. The time was right. It was a wet Saturday morning in April 1978. Steve and I couldn't believe our eyes when we saw the length of the queue of people waiting for the shop to open. It was a memorable day. People had come from all over the country for the opening of what was to be the first of many Games Workshop shops. I hope one day to again meet some of the people who were in that queue! If it was you, please contact me through Twitter @ian_livingstone.



Figure 17: "Van Morrison"



Figure 18: Games Workshop (Opening Day 1978)

How else did you add value to your brand?

We recognized early on the need to have visualisation of our own character types in the games. This led to us opening our own factory in Nottingham with Bryan Ansell¹ up in Nottingham. That was how Citadel got started.

Games Workshop stores as a brand, of course, continues to grow. The original store was in Hammersmith in West London, not far from where I live today. In fact, I drive past it still, and I stopped the other day to take a photo. It has now become the Bosnia & Herzegovina Community Advice Centre. I guess we all move on.

How did Games Workshop move on to Warhammer?

Warhammer, got started because, although we had a three-year licence for D&D, and got us off to a flying start, we didn't own that IP. It is critically important to actually own IP, rather than working on other people's IP. We understood very clearly that we couldn't retain forever an exclusive licence to sell D&D, and that when the market opened up, our business would come under threat. So Warhammer was explicitly designed to replace D&D and to give us far better control over the future of our business. That was a valuable lesson in life for me. If you want to determine your own destiny you have got to create your own IP and, somewhat later, that is something I carried forward with EIDOS.

Our miniature figures moved from metal to plastic, for convenience and to be easy to paint, etc. I'm no longer associated with Games Workshop, as Steve and I sold out in the early nineties, but it continues to flourish and, as we all know, is the largest hobby games company in the world but it is still very much centred on promoting the sale of its miniature figures, and all that promotion backed around White Dwarf. It's exclusively, virtual integration, manufacturing content, and retail sales, and on-line sales, related to selling Warhammer figures.

Before moving on from discussing Games Workshop, I wonder if you could tell me something about the origins of the iconic Games Workshop logo?

Yes, of course. The Games Workshop, used various kinds of logos over the years, until it got the Games Workshop logo you see today. That was originally produced by Iain McCaig², for a plastic bag but we took the artwork off the bag and put it on the store, where it remains to this day, which is good to see.

How did Fighting Fantasy series come about?

Steve and I realized that D&D, was still very heavily niche, and we wanted to broaden the audience because we knew that interactive gaming, based on branching narrative, especially in the fantasy world, was very appealing. So we decided to try to expand role-playing.

Fighting Fantasy got started because we used to hold a convention called "Games Day" in London, and we encouraged other traders to take stalls at the show. One of those

¹ http://en.wikipedia.org/wiki/Bryan_Ansell

² http://en.wikipedia.org/wiki/Iain_McCaig

was Penguin Books, and the editor, Geraldine Cook, was amazed at how large and enthusiastic the crowd was given the obscurity of role playing at the time. She asked Steve and I if we could write a book about role-playing. We said that rather than writing a book *about* the subject, it would be much better to write a book that allows the readers to *actually do it*. She thought that was a good idea.

We dithered for a little while because we'd already floated the 'interactive book' idea to the publishers of 'Lord of the Rings', George Allen Unwin from whom we had received a very quick, swift and short reply, effectively saying "Go away!". As it turned out, this was very much to our advantage as it freed us to do our own thing, with the added benefit that we would be creating our own intellectual property. So we created "Warlock of Firetop Mountain"¹, the manuscript.

How did you divide up the work?

I wrote all the front bit up to the river in the book, and Steve wrote all the river and beyond, but we had contrasting styles, and in the end Penguin, asked us to put it in a consistent style throughout. We effectively flipped a coin, as the result of which, Steve ended up having to rewrite the whole thing into one adventure. This was a very good - for me. Warlock was published in 1982, but without much success. We promoted it a little bit through White Dwarf, and did our own PR, but Penguin Books, who marketed it through the Puffin brand, didn't do much at all.

How did Fighting Fantasy become popular?

It eventually started to do well in little pockets around the country. Through word of mouth, schools heard about this funny book where you, the reader, make the choices, and you have to live with the consequences of your choices. This was much more compelling because the reader becomes the central character in the book. This was much more engaging than those boring, passive books where the reader is merely presented with a linear story, and simply goes where the author takes them. Quite suddenly these pockets started to spring up all around the country, and again it just goes to prove that word of mouth is the best PR you can get. And despite having received zero promotion from Puffin, Warlock suddenly sold out. So Puffin reprinted a very small number, like 5000, and then another 5000 and I think they did eleven reprints before finally coming back and saying "Can we have some more please?"

We decided that having been such a nightmare writing the first one, it would be better to do separate versions. So Steve then wrote of "The Citadel of Chaos" and I wrote "Forest of Doom" and the whole Fighting Fantasy thing took off. The Green-spined books as they were familiarly known in the eighties, numbered fifty-nine, and try as we might we couldn't keep up with demand. In order to meet the demands Puffin were making of us, we had to engage ghost writers to help us write them. It thus became "Steve Jackson and Ian Livingstone present....".

¹ http://en.wikipedia.org/wiki/The_Warlock_of_Firetop_Mountain

How do Fighting Fantasy books work?

In a branching narrative, at the end of each paragraph, you have to make a choice. For example, you may be given the choice to ask a character in the book for something out of his backpack, or you might prefer just walk past him. Depending on the choice you make, you are directed to another section of the book, thus you must live (or perhaps die) by your choices. There are hundreds of ways of going through these books but only one real ‘correct’ way. Deathtrap Dungeon¹, one of mine, was particularly popular at the time. They are still being licensed, in 26 languages now, more recently in Chinese. I hope we get royalties! We’ll see. They’ve just been licensed in Taiwan too and there have been enquiries in Russia. So, they are very much alive.

Five years ago Steve and I did a celebration of the 25th anniversary of Warlock of Firetop Mountain and this year, we are producing a brand new Fighting Fantasy book called “Blood of the Zombies”. This will be published on the 2nd August 2012, exactly 30 years after Warlock, so I’m looking forward to that. Of course, it’s going to have a fraction of the sales of back then, but it’s a really important thing to do, and I’m really enjoying writing it.

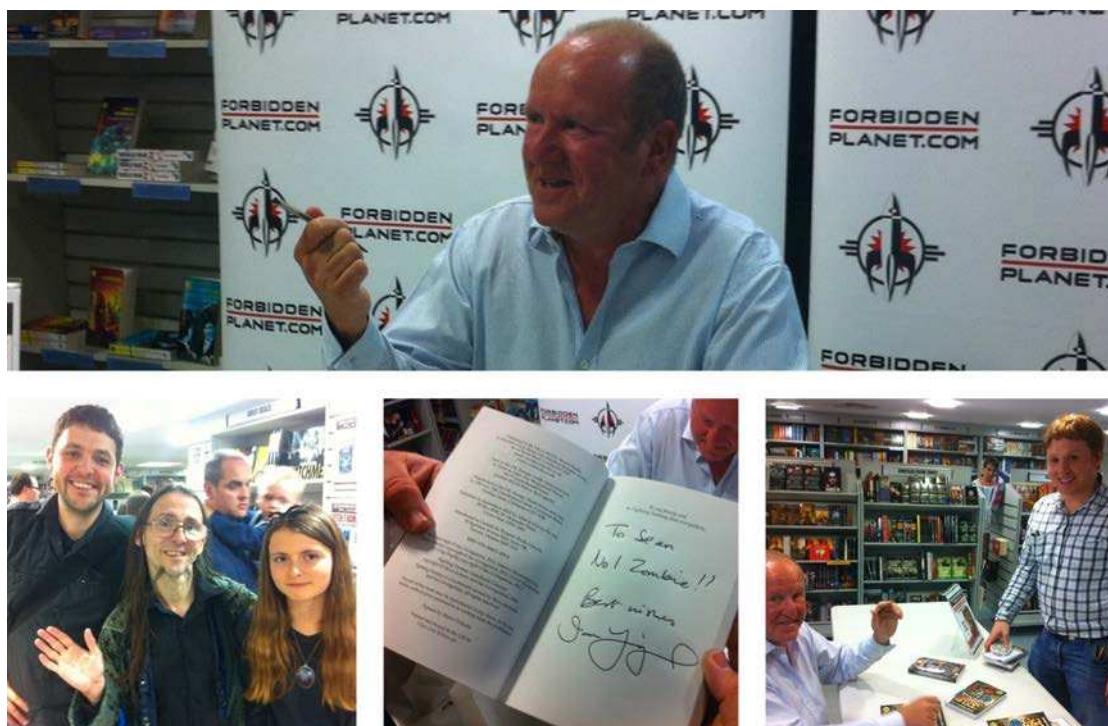


Figure 19: 4th August 2012 Launch of "Blood of the Zombies" at Forbidden Planet, London

Where would you say Fighting Fantasy fits into the larger gaming scene?

Looking back, it is clear that, in many ways, the paper and pencil based gaming in the style of D&D represents an important pre-technological precursor to videogames. What, for example, would World of Warcraft have been without Dungeons and Dragons?

¹ http://en.wikipedia.org/wiki/Deathtrap_Dungeon

So, did Fighting Fantasy give you an entrée into the world of computer games?

At the height of Fighting Fantasy, I was asked by a new British (UK) development company called Domark¹, to write their first game “Eureka!”², I’ll say right now, I couldn’t write a line of code, I still can’t, I’ve always been on the design side. We actually had this game programmed in Hungary for secrecy, because there was a £25,000 prize attached to the first person who could solve the Eureka! mystery. I remember presenting the cheque on television, which was very exciting. So Domark also published “Championship Manager”³ and Domark became EIDOS⁴, as four companies merged into one new company. At this point, I’d been asked to join the company and was chairman of the publically quoted company EIDOS from 1995-2002.

In turn, EIDOS was acquired a couple of years ago by Square Enix⁵, one of the large Japanese publishing houses. Square Enix, have now got three brands, most famously their own “Final Fantasy”⁶, (no connection with Fighting Fantasy), the EIDOS brand with all of our original IP, games like Hitman⁷, Deus Ex⁸, Thief⁹, Championship Manager, Just Cause¹⁰, and Square Enix also own Taito¹¹, who own Space Invaders¹². So they’ve got a global content business, created by a global development community, not aimed at any one particular part of the world, but addressing global audiences.

Can you say a little about your perspective on the history of games?

Obviously there were games or games simulations before the sixties. I think it all goes back to 1949 or 1950, but the first one that I was aware of was Space War¹³, with Steve Russell¹⁴. This featured two spaceships with limited fuel and missiles, fighting in space. That was never really commercialized, so it wasn’t really until Pong got going that the world at large took much notice. Of course there was Richard Bartle’s¹⁵ MUD¹⁶, which I went down to play in 1981. God, that’s 30 years ago! It’s getting depressing this conversation.

But Pong made it thanks really to the commercial nous and clout of Nolan Bushnell¹⁷, who pushed the whole Atari¹⁸ Company forward. But computing and videogames in the home really got started with the Magnavox Odyssey in 1972, but they made a classic marketing mistake in their advertising, they implied that for the Magnavox

¹ http://en.wikipedia.org/wiki/Domark_Software

² [http://en.wikipedia.org/wiki/Eureka!_\(computer_game\)](http://en.wikipedia.org/wiki/Eureka!_(computer_game))

³ http://en.wikipedia.org/wiki/Championship_Manager

⁴ http://en.wikipedia.org/wiki/Eidos_Interactive

⁵ <http://www.square-enix.com/>

⁶ http://en.wikipedia.org/wiki/Final_Fantasy

⁷ [http://en.wikipedia.org/wiki/Hitman_\(series\)](http://en.wikipedia.org/wiki/Hitman_(series))

⁸ http://en.wikipedia.org/wiki/Deus_Ex

⁹ [http://en.wikipedia.org/wiki/Thief_\(series\)](http://en.wikipedia.org/wiki/Thief_(series))

¹⁰ [http://en.wikipedia.org/wiki/Just_Cause_\(video_game\)](http://en.wikipedia.org/wiki/Just_Cause_(video_game))

¹¹ <http://en.wikipedia.org/wiki/Taito>

¹² http://en.wikipedia.org/wiki/Space_Invaders

¹³ http://en.wikipedia.org/wiki/Space_War

¹⁴ http://en.wikipedia.org/wiki/Steve_Russell

¹⁵ http://en.wikipedia.org/wiki/Richard_Bartle

¹⁶ <http://en.wikipedia.org/wiki/MUD1>

¹⁷ http://en.wikipedia.org/wiki/Nolan_Bushnell

¹⁸ <http://en.wikipedia.org/wiki/Atari>

machine to run, you needed a Magnivox television, which wasn't true, and it also cost them dearly because people said, I haven't got a Magnivox television, so I'm not going to buy this console. It was also a dedicated console, and you could only play one game on this machine. So it fell to Atari to make the breakthrough with the 2600 in 1977, here was a console that could plug into any television and it also had interchangeable cartridges, therefore you didn't have to keep buying new hardware. The net result of this was that about 40% of the American population started playing videogames in the home. And, of course, not wanting to be left out the Japanese jumped on board the opportunity and really established the arcade games like Space Invaders, and Asteroids, were hugely successful. Indeed, so much so, that there was shortage of 100 yen coins in circulation, and the Japanese mint had to do an emergency mint because they were all stuffed in Space Invader machines.

The big move was from 2D side scrolling to 3D gaming which really resulted in huge amounts of popularity around the world in gaming. So, a big turning point in the mid-nineties when Playstation was launched, of course it's software that sells hardware, and so games like Tomb Raider, and Wipeout, drove that platform to huge success. Of course today we have huge platform diversity, so many gaming devices are available for a wide variety of content. Contrary to the popular press, it's not just about killing things, or kicking people, there's something for everyone. Male and female, young and old are playing games, whether it's nurturing ponies or brain training, or Angry Birds etc., there's something for everyone now in games.

So, if you look at the market, it's \$50bn a year, the market for games, it's going to rise to \$90bn by 2015. We are very good at generating emotions with games. It's interactive, not linear, therefore we're interacting with our audiences on a much more compelling basis.



Figure 20: Angry Birds¹

¹ https://images-na.ssl-images-amazon.com/images/G/01/videogames/detail-page/B008J16AQK_img1.jpg

People sometimes claim Computer Games as a modern art form, others just see them as a business. What is your opinion?

The fact that we can generate emotion from people, and there's so much visual beauty, story and narrative, and music, clearly it is art. Well BAFTA certainly think so, we have BAFTA games awards every year. To my mind it is absolutely, 100% art. In terms of money, there are also some pretty artistic numbers involved. The industry is now bigger than DVDs, bigger than cinema box office, bigger than music, and bigger than books. Of course the console was the dominant platform from the mid-nineties through till quite recently, although that is in a very mature space now. Whilst there are still console blockbusters available, it really has matured and it's gone to a triple-A basis now. If you're not best in class and, in particular, genre, you might as well just give up now because there's so much other choice on other platforms available, people are all buying the same game. But it's kind of triple-A, or the highway. Modern Warfare III¹, sold 6.5m units on one day in the US and the UK alone, generating \$400m. That's bigger than any other entertainment release in any other media. It has now generated over \$1bn. But I'm afraid there's no room for the B class titles, because people are playing the triple-A titles and the rest of the time they won't try out another one for the sake of it, they'll have a go at another device whether its iPhone or Android device, Smartphone or tablet, or playing games on Facebook.



Figure 21: Call of Duty: Modern Warfare III²

What effect are computer games having on society?

We can put some quantum on games, and how they're having an effect on society. There have been 400m downloads of Angry Birds, people like the Prime Minister say

¹ <http://www.callofduty.com/mw3>

² http://thegamefanatics.com/wp-content/uploads/2012/08/call_of_duty_modern_warfare_3_by_stiannius-d3g8llx2.jpg

they play Angry Birds. It's very much part of our society. You've got 50m users of Moshi Monsters¹, this is a great British success story, from Mind Candy² now situated down in Tech City. You've got 550m people playing Farmville.



Figure 22: Farmville³

Do you still see plenty of opportunity in the games market?

Games have actually moved from a niche to a mainstream audience, children play, young people play, old people play, everyone's playing games these days. The games industry is in a constant state of change and never more so than today. I don't want to bore you with the economics of the industry, but there has been a huge swing away from packaged goods into online delivery of content and consumption of games. The tipping point is likely to be perhaps this year maybe next year where more revenues will be derived from digital sales than boxed products.

So the whole rationale and existence of traditional publishing is under threat. But at the same time it creates amazing opportunities for new people to reach global markets through high speed broadband. Whilst there is a lot of threat there is also a lot of opportunity. So, to my mind a second golden age of games is happening today, rather like it was in the eighties, where small agile teams can just iterate, put something out there, it doesn't work, it does work, we'll see, do it again. Fantastic opportunities now, because there are so many more digital platforms on which they can launch their content, from

¹ <http://www.moshimonsters.com/>

² <http://mindcandy.com/>

³ http://vator.tv/images/attachments/020909121934gameBig_farmville.jpg

traditional console opportunities, of course, to Android, IOS and Facebook, and casual games sites.

What do you see as the main problems facing games preservation?

It's a problem for you rather than me! Not just the analogue, how are you going to deal with the digital, how are you going to deal with products as a service, how are you going to turn off the tap, how do you actually archive something which is just effectively streaming from servers? It's proliferating all the time, new content being added, and is effectively for ever in Beta, the finished product never happens, because content is added almost on a daily basis. So how do you preserve something that's constantly changing?

There are "design-your-own" games now. One example is Minecraft, and it's a beautiful experience. This was produced by a one-man team – the Swedish programmer Markus "Notch" Persson and later developed and published by Mojang. Again it shows the opportunities that are out there. This is probably out of date now, but there have been at least three and a half million purchases of Minecraft. It's a kind of beautifully crafted, retro-style really fantastic experience. So if you haven't played it, I do recommend that you do.

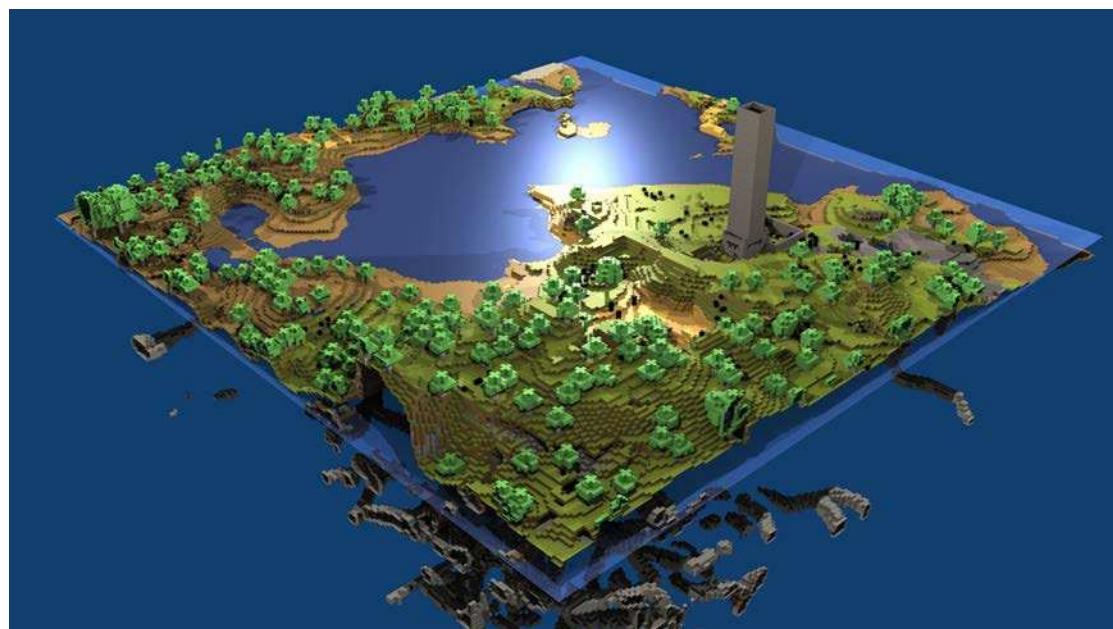


Figure 23: Minecraft¹

Persistent worlds, how do we archive those? Games like World of Warcraft, casual games, there's hundreds of thousands of casual games out there, on approximately 50,000 games portals, serving free-to-play, flash games. How are we going to address that issue, how are we going to find them and archive them, which ones are worth archiving? The big trend now is not just mobile games, but social mobile games. Games like Words with Friends. You can play cross-platform as well, on Facebook, and also, of course, on your mobile device. This new engagement, making invitations to people to play because getting visibility on the i-store now is so difficult, it's the world's smallest shop window.

¹ <http://img.gawkerassets.com/img/17svxowy0twg1jpg/original.jpg>

With hundreds of thousands of applications on there, how are you actually discovered. So using the invitation like with Words with Friends where you invite someone to go and play, and all they're doing is going to the i-store to make a purchase that they've already decided on, rather than just trawling through the i-store, hoping that they might stumble on something they might want to play. There is such great innovation happening in the mobile space. Tiny Tower is just one example of a great game, a two-man team, with extraordinary success, almost too much success, because apparently Zinger now are making, shall we say, a game not too dissimilar to the essence of Tiny Tower, is it called Dream Tower?

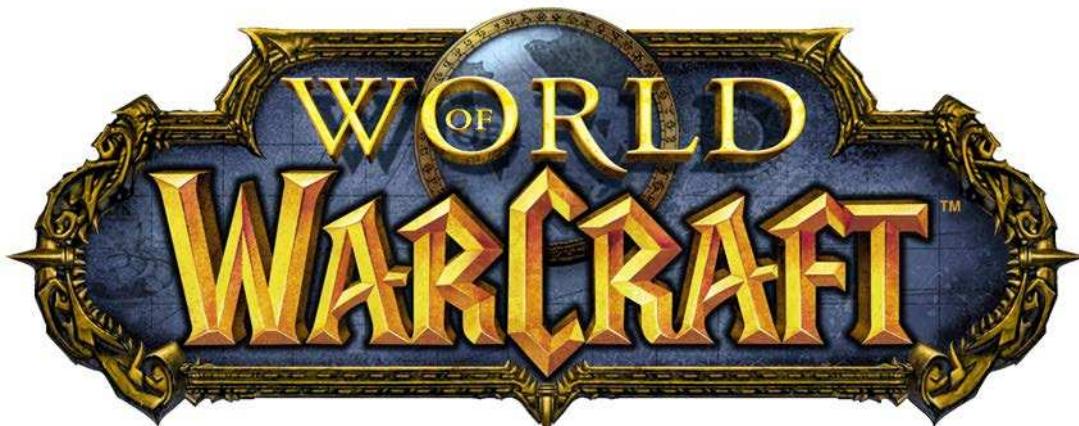


Figure 24: World of Warcraft¹

Again opportunities but also threats. Smart phones, and tablets and Facebook. And talking about Facebook as a games platform, it didn't exist a few years ago, neither did the i-phone and that's the beautiful thing about games, that technology drives innovation, opportunity for games, which is brilliant. So if you think about Facebook as a platform, and the users that it has now got.

It took 38 years for radio to get 50m users, 13 years for the TV, 8 for the Internet, 3 for the mobile, and yet 200m people are on Facebook in less than a year. Now, it's 600m, 700m who knows? It's going to be billions soon. And half that audience plays games, so again, it's another fantastic opportunity for content creators. Cityville launched, after Farmville from Zinger, it had 100m people playing it with 44 days.

These are extraordinary numbers and opportunities. People talk about 'gamification', there is 'shopcade', it's a social shopping game site with a Facebook application and gaming elements launched in November 2011 by Nathalie Gaveau², Marie-Barbe Girard³, Hoon Kim⁴ and Evan Adelman⁵. So as traditional retailers and product people look to have a sticky, greater engagement with people by using gaming elements to get traction with their audience, so games are popping up everywhere. And of course we create beautiful and wonderful characters, we create very valuable intellectual property.

¹ http://sickr.files.wordpress.com/2012/03/world_of_warcraft_logo_large.png

² <http://www.crunchbase.com/person/nathalie-gaveau>

³ <http://www.yatedo.com/p/Marie+Barbe+Girard/normal/ed04a17a5938ee14c33c33d2117114e5>

⁴ <http://www.zoominfo.com/#!search/profile/person?personId=1768551234&targetid=profile>

⁵ <http://www.zoominfo.com/#!search/profile/person?personId=1434371334&targetid=profile>

What was the contribution made by the UK?

Well, we know about Richard Bartle and MUD, and Elite, and Manic Miner. We were right in there at the beginning and why is that? Well, I think we are possibly one of the most creative nations, if not the most creative nation in the world. We have always been very good at Technology and, of course, we have a sort of heritage of computing early on thanks to the BBC and the BBC Micro in schools in the 1980s and the Sinclair Spectrum being an affordable computer in homes in the 1980s.



Figure 25: The BBC Micro¹

Some of the best console games in the world were created in the UK. We are very good at creating original content. We've had a huge success with Moshi Monsters and online with RuneScape² from JAGEX³ a million subscribers there, social games like Gourmet Ranch⁴ by a company called Playdemic⁵, up in Wilmslow, Broken Sword⁶ from Charles Cecil⁷ on Mobile Games, I think he had 4 millions downloads over Christmas, with their sort of 'Happy Christmas' announcement, and this again is an opportunity for old content to re-emerge on new platforms, and Charles has had a wonderful success with Broken Sword. There's a lot of UK games studios in the digital space, this is just a sample of them, it's certainly not all of them, but they're springing up everywhere, which is a great thing to see. But sadly, we lost lots of our heritage.

¹ <http://static.guim.co.uk/sys-images/Observer/Columnist/Columnists/2012/3/22/1332439030864/bbc-micro-008.jpg>

² <http://www.runescape.com/>

³ <http://www.jagex.com/g=runescape/p=2sA9c0-ltLB7H6LqG1ya8HsfouobXJr4Av4RGYIPRo/>

⁴ <http://apps.facebook.com/gourmetranch/>

⁵ <http://playdemic.com/playdemic-original-owners-rebuy-from-rockyou.aspx>

⁶ http://en.wikipedia.org/wiki/Broken_Sword:_The_Shadow_of_the_Templars

⁷ http://en.wikipedia.org/wiki/Charles_Cecil

Can anything be done about that?

Recently, I've been involved with the Next Gen report which we launched in February 2011¹. I'd been moaning to the Culture minister, Ed Vaizey, about the fact that couldn't hire enough quality computer scientists in this country for some of our studios, and so he tasked us with writing this report.



Figure 26: The Next Gen Report²

You can see the film that we put together to help show the problems that we were facing. We started off by looking at universities, the fact that there were 144 university courses in the country with the word "Games" in the title, but many of them were masquerading as games courses, but were nothing more than media studies courses with the word 'media' crossed out and 'computer games' inserted. They were teaching largely things about the philosophy and social relevance of games in society and a little bit about games design, but not relevant games design.

They weren't teaching students the hard skills to make them. What you need is computer scientists, artists and animators. And we realised talking to people like David Braben³ that, sadly, Computer Science was falling off Cambridge University at 10% year on year decline in students applying to do Computer Science. So then we had to look at schools and there lay the problem that as ICT is currently taught, while it's useful to learn about Office and secretarial skills, it was absolutely totally useless if you wanted to have a career in our industry in particular. Because learning Word, Powerpoint, and Excel is not going to get you a career in our industry. We are teaching our children how to use applications, but not how to make them. It's the difference between reading and writing, we teach our children to read but not to write. We teach them to effectively become a slave to a user interface, we don't encourage them to delve into creative learning and creative building of content. So we needed to give them some digital building blocks, they needed some computer science in their lives, and certainly some computer

¹ http://www.nesta.org.uk/events/assets/features/next_gen

² http://www.nesta.org.uk/publications/assets/features/next_gen

³ http://en.wikipedia.org/wiki/David_Braben

programming, we need some computational thinking, logic, set theory, matching their inherent creativity with technology that could empower them to create digital content. Our number one recommendation was to bring computer science into the schools' national curriculum as an essential discipline. What happened was we also created a Next Gen skills campaign which is a cross section coalition, not just about games and visual effects companies, because the lack of computer science is also relevant to everything in the world, anything that creates any digital content whether it's fighting cyber crime, or financial services, or designing the next jet propulsion engine, you need computer scientists. It touches everything we do. So Next Gen skills is a broad coalition in which we have lobbied the government for some time. These are some of our Next Gen partners now, who have signed up: Google, Microsoft, some heavy hitting companies, we've got some other heavy hitters about to be announced. But our Next Gen report was largely ignored by Government, especially DFE¹, so whilst the DCMS² and Ed Vaizey was saying this is great, the door to Sanctuary Buildings³ and DFE was firmly shut. We also talked about the Raspberry Pi, how that could possibly be the BBC nano of the future, here was an affordable (£15) computer, programmable, comes with Linux installed, and Scratch, and other open source programs, which could get people computing in schools for £15. Plug into a keyboard, plug into a TV and you're up and running.



Figure 27: Ed Vaizey, UK Minister for Culture, Communications and Creative Industries⁴

But it wasn't really until Eric Schmidt⁵, in August 2011, made reference to our report in his Q&A, and lambasted the UK over its throwing away its heritage of computing, the fact that we'd invented the Colossus, the first computer, and we used to engage with polymaths, and since then we've made children choose between science and

¹ Department for Education

² Department for Culture Media and Sport

³ London HQ of the Department for Education

⁴ <http://static.guim.co.uk/sys-images/Guardian/Pix/pictures/2010/8/12/1281633933930/Ed-Vaizey-006.jpg>

⁵ http://en.wikipedia.org/wiki/Eric_Schmidt

art, kind of disregarded our absolute heritage. And having referenced Next Gen, suddenly people were interested.



Figure 28: The Raspberry Pi Computer¹

The Prime Minister, said in a speech at Tech City, about the need for Computer Science, and culminating in Michael Gove², last week, that the current study of ICT was going to be withdrawn from the curriculum, to be replaced by a kind of wiki-style curriculum involved heavily around computer science. We managed to get to his advisors after Eric Schmidt, and had some fantastic meetings with special advisors. Now we know who runs the country. It's not the Civil Service, it's not the Ministers, it's the SPADS, the special advisors who make all the decisions. If you can get to the SPAD, you make fundamental changes to the world.

So Michael, having spoken to his special advisors, and David Cameron's special advisors, managed to get this breakthrough, resulting in the speech made last week by Michael Gove. So this is a fantastic opportunity, now we've got to deliver. Not all schools will be able to implement this, although the British Computer Society Committee on schools, say they've got about 1000 teachers in schools that can actually implement the recommendations on computer science. But you've got to start somewhere; you can't fall further and further behind. So computer clubs, engage with industry to get people into schools. They're not necessarily teachers today, but anything that can be done to create a curriculum, working with Google, Microsoft and e-skills, to get computer science into the classroom in a positive, creative way, is a good thing. So we're going to carry on our bit with Next Gen, and if you're interested in finding out more, you can always write to our campaign manager, who is Theo Blackwell of Next Gen Skills campaign at www.nextgenskills.com and join it.

¹ http://news.bbciimg.co.uk/media/images/58759000/jpg/_58759696_pi2.jpg

² http://en.wikipedia.org/wiki/Michael_Gove

Several times during this interview, you have mentioned the importance you place on companies developing and exploiting their own IP. Perhaps the IP with which the current generation associate you most closely, is Lara Croft and Tomb Raider. Can you say something about Lara?

I've effectively been acting like a father for her since she was released on the world in 1996, but I didn't design her, that was Toby Gard¹, our artist at Core Design where Tomb Raider was being developed. When we (EIDOS) acquired a publically quoted distribution company called CentreGold² in 1996, Core Design came along as part of the deal. As part of the due diligence process, we went to see Core Design and met the team that were creating Lara Croft. It was more or less love at first sight, and we launched Tomb Raider in November 1996.

How did Lara Croft come about?

Well Core was mainly a PC developer, and in those sort of Wild West days, obeying copyright was not always at the forefront of their mind. Toby was asked to replace a character called Rick Dangerous in a game that was going to appear on Playstation.

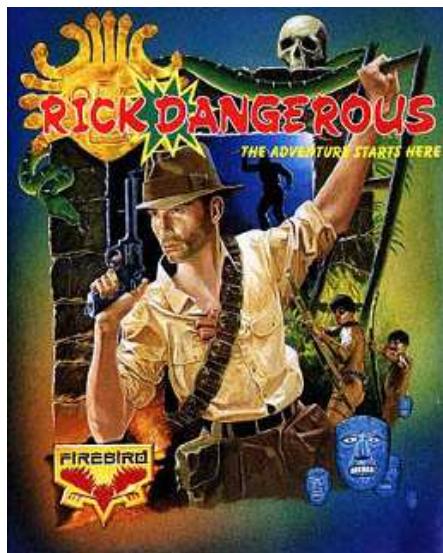


Figure 29: Rick Dangerous Box Cover

Now he thought it might be better to have a game where he could be safe and secure in the knowledge that the IP you were publishing was actually yours. So he was asked to do this character to replace Rick, who has a certain similarity to a film star, whose name I have forgotten, and he set about doing it. So everyone thought he was going to create a male character but he was inspired by Tank Girl, the rise of 'girl power', and Neneh Cherry³. He suggested Lara Cruz - the name 'Lara Croft' came later - as a female character.

At that time, 100% of characters in games were either fluffy animals or mighty-muscled barbarians, so why not have a female character? This was going to be the very first game on a console, with a 3D character, moving into a 3D world, so you are looking at the character from behind. It was going to appeal to men and to women, because a large number of women were now playing games. Toby suggested a character

that would appeal to male and female. Lara was strong, intelligent, dextrous, adventurous, athletic, actually didn't need men. Women wanted to be Lara Croft, and men wanted to play with Lara Croft. So that was the rationale.

¹ http://en.wikipedia.org/wiki/Toby_Gard

² <http://en.wikipedia.org/wiki/CentreGold>

³ http://en.wikipedia.org/wiki/Neneh_Cherry



Figure 30: Toby Gard original concept art for "Lara Cruz"¹

When she emerged in 1996, I think we had allowed for about 100,000 units in the budget, but actually sold 7 million copies, so it was an extraordinary success.

Lara Croft very quickly acquired significance beyond the computer games world, did she not?

Lara became an international pop-culture phenomenon and graced the covers of not just games magazines, but lifestyle magazines. In a Times digital survey, a number of years back, in recognition terms she featured more votes in recognition than the Pope. So she had a real impact. We even have a road in Derby, called Lara Croft way!

There has been parody around Lara Croft; there has been notoriety around Lara Croft and some anecdotal stuff as well. David James, who was then the goalkeeper for Liverpool and England, he let in four really terrible goals, and the back page of the Times was devoted to a story saying he let those goals in because he had spent the whole night playing Tomb Raider. Prodigy were a year late delivering their album and said they spent the whole year playing Tomb Raider and of course there's been things beyond the game, like Theme Park rides, movies.

¹ http://i961.photobucket.com/albums/ae95/games405/Gard_concept_art.jpg



Figure 31: : The first render of Lara without a ponytail, and with suspiciously thin knees.

A lot of people think that the movie came first, whereas it was, in fact, the game. We extended the IP of the franchise into merchandising and licensing the game and movies.



Figure 32: Lara Croft - Cover Girl

We had a veto over the cast and the script because we didn't want Hollywood taking Lara Croft in a direction we didn't want her to go because she was the most important thing we had in our portfolio. So when we were talking to the production

company, Larry Gordon¹, representing Paramount said, we'd like to use Angelina Jolie to play the role of Lara Croft, we said that's absolutely fine with us, no problem you go ahead. So we met her a couple of times on the set at Pinewood, I'm still recovering from that!



Figure 33: Angelina Jolie (as Lara Croft)

Finally, what next for computer games?

The future is mobile, social mobile is going to be the future in games, connected devices, people playing anywhere, with anyone around the world, on the fly. The future is also going to be cloud, I don't know how that's going to effect archiving or how you archive the cloud but everything streaming, no downloads from remote servers is going to be particularly challenging from an archivist's point of view. But games do make an important contribution to the economy, there are certainly social, they are certainly cultural, and have very much been a part of my life.

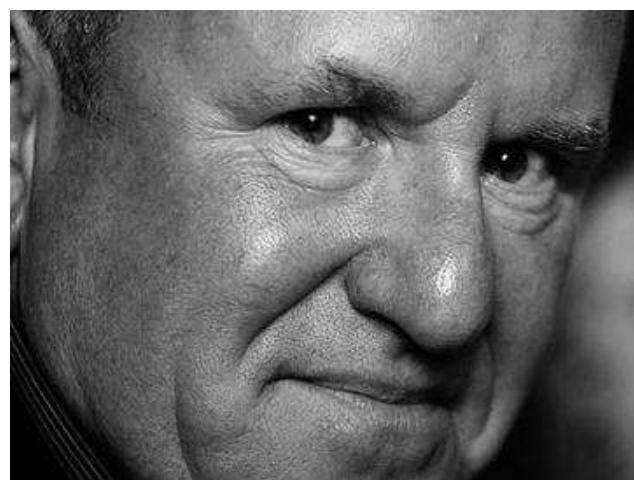


Figure 34: Ian Livingstone CBE

¹ <http://www.filmreference.com/film/55/Lawrence-Gordon.html>

A Tangled Web: Metadata and Problems in Game Preservation

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Abstract. The Preserving Virtual Worlds project has been investigating the preservation of computer games and interactive fiction for the past several years. Many of the problems in preserving these complex digital objects are fundamentally problems of description. This paper summarizes the problems encountered by the project in attempting to archive computer games and discusses the application of the OWL ontology language with existing library metadata standards as a possible solution to those problems.

Preserving Virtual Worlds: An Introduction

At the beginning of the first decade of the 21st century, the digital preservation community faced a world in which models for preservation were at best inchoate and functioning preservation systems practically non-existent. By the end of the decade, functional, data and economic models (CCSDS, 2002; CCSDS, 2008; Kejser, Nielsen & Thirifays, 2011; Hole et al., 2010) were developed and under active refinement, and open source software for repository systems intended to preserve digital content, such as DAITSS, DSpace, ePrints, iRods, and LOCKSS¹, were well-developed and in production use at a variety of institutions. Our knowledge of digital objects and our ability to manage and preserve them has undergone a dramatic advance.

The inevitable price of these early successes, of course, has been the discovery of even more difficult problems. As we apply the models and tools developed to date to support digital preservation efforts, we encounter new and more complex problems in the technical, legal and administrative aspects of digital preservation. This is particularly true with respect to commercial digital media, where the complex technical nature of these objects combined with their equally complex intellectual property status (and our occasionally challenging intellectual property laws) create an administrative headache for anyone trying to preserve these digital works in the long-term. Web archiving, interactive fiction and multimedia, and software of all sorts present a number of issues with which the digital preservation community has struggled, but cannot yet be said to have completely solved.

The Preserving Virtual Worlds project, a joint effort of the Rochester Institute of Technology, Stanford University, the University of Illinois, and the University of

¹ DAITSS (Dark Archive in the Sunshine State) is a preservation repository for digital documents developed at the Florida Center for Library Automation for the use of libraries in Florida's publicly-funded universities (<http://daitss.fcla.edu>). DSpace and ePrints are both digital institutional repository systems designed for universities to preserve scholarly content (e.g., papers, theses, teaching materials, white papers) (<http://www.dspace.org> & <http://www.eprints.org>). iRods is a rule-based data management system targeted at the preservation of digital materials, and designed to operate as part of a data grid architecture (<http://www.irods.org>). LOCKSS (Lots Of Copies Keeps Stuff Safe) was created at Stanford University as a means of preserving web-based electronic journals (<http://lockss.stanford.edu>).

Maryland, has been studying one sub-domain of these problems, the preservation of computer games, for the past four years. With support from both the Library of Congress' NDIIP Program and the Institute of Museum & Library Services, our team has investigated what makes digital games difficult to preserve, how we might approach the preservation of these complex objects using existing tools, and how the significant properties of these objects are defined by their creators and users. As might be expected, a close examination of computer games reveals that they pose a number of unique challenges to the digital preservationist.

One of the keys to confronting those challenges is creating and maintaining appropriate metadata for the objects to be preserved. It is fair, in fact, to say that generating adequate descriptions of the games we wish to preserve is as significant a preservation activity (if not more) than choice and implementation of a preservation strategy for the game. Preservation of computer games is in many ways a knowledge management problem, and without adequate metadata, managing the knowledge necessary to keep a game accessible and *understandable* is an insurmountable task. The remainder of this chapter will discuss in detail the problems our project has encountered in trying to preserve computer games, how properly designed metadata may help alleviate some of those problems, and discuss some of the issues still waiting to be solved in the metadata realm.

Problems in Game Description

The Preserving Virtual Worlds project has adopted a case set methodology in our study of computer games. We have tried to select games from differing periods of computer history, for different platforms, and of different genres in order to try to identify as wide a range of potential problems as possible. Games we have studied in our research include:

Spacewar! (1962)—One of the earliest computer games, developed at MIT as a demonstration program for the PDP-1 computer from DEC.

Adventure (1977)—Originally developed by William Crowther and Don Woods, Adventure was one of the earliest text adventure games and had a significant impact on the culture of early Internet users.

Star Raiders (1979)—Originally released for the Atari 8-bit computers, Star Raiders became one of the more popular games for the Atari 2600 game console.

Mystery House (1980)—Developed by Roberta and Ken Williams, this is the first work of interactive fiction to employ computer graphics as a significant part of the game.

Mindwheel (1984)—An interactive fiction work, authored by U.S. Poet Laureate Robert Pinsky.

Doom (1993)—Developed by iD Software, Doom popularized the first person shooter game, and spawned an entire culture of third party gaming development/modification.

Warcraft III: Reign of Chaos (2002)—The popular, real-time strategy game from Blizzard Entertainment provided the foundation for Blizzard's World of Warcraft multiplayer online role-playing game.

Second Life (2003)—The virtual environment created by Linden Lab has been one of the most successful of the “social” (i.e., non-gaming) virtual worlds and presents numerous interesting issues around intellectual property and preservation. Given the large amounts of data involved in archiving all of Second Life, our

project focused on three particular islands in Second Life: The International Spaceflight Museum, Democracy Island, and LifeSquared.

Typing of the Dead (2000 – Present)—Based on a Japanese arcade game named *House of the Dead*, this educational game for the Sega and Windows platform attempts to hone students' typing skills by using them to defeat attacking zombies.

Oregon Trail (1970 – Present)—One of the longest running game series, *Oregon Trail* is a simulation game challenging students to survive travelling the Oregon Trail in the mid-19th century. It has been used extensively in K-12 education in the United States.

The first problem to present itself in our study of computer games was the fact that computer games have very poorly defined boundaries. We tend to think of software as a relatively discrete item, something that has a completely independent existence from our operating system and computer. The underlying technical reality, however, is obviously quite a bit different. Games possess hardware and software dependencies that make separating them from the platform on which they are intended to run difficult or impossible. One of the older games we studied, *Adventure*, was developed by two separate individuals, initially by William Crowther and subsequently by Don Woods. One of the first actions Mr. Woods took to modify Will Crowther's original code was to re-implement a library function that existed on the operating system for the PDP-10 that Will Crowther used for development, but which was not part of the operating system on the Stanford University computers to which Don Woods had access. Modern computer games rely extensively on dynamic software libraries included in operating systems such as MS-Windows and OS X. At the end of the day, a functioning computer game requires game software, an operating system and computer hardware operating in tandem. Drawing a clear line and saying, "this is part of the game, and that is not" can be a challenging proposition. Without that distinction, however, we start the task of preservation with either an unfortunate lack of clarity as to what exactly we are preserving, or a commitment to maintaining complete systems, including hardware, which may profoundly hamper long-term preservation.

Related to this problem are the issues of versioning and version control, both at the game level and the component file level. Successful games such as *Doom* will become on-going franchises with multiple versions of the game released over the years, and each version may be made available on a number of different platforms. Moreover, the individual component files comprising the game may each have multiple versions as the result of on-going game enhancements or bug fixes. Producing a workable copy of a game is not just a matter of having all the software and data files necessary, it is also a matter of having the right *version* of all of the files. Tracking these version changes, and the relationships that exist between files in a game, and between files in the game and specific files in an operating system (e.g., a particular patch level of a dynamic load library), is essential if we are to maintain access to the game.

Maintaining access to the game itself, while obviously a necessary condition of game preservation, is not in itself sufficient. Our goal as preservationists needs to go beyond maintaining the technical interpretability of a game to insuring what we might call its social interpretability, the ability of scholars in the future to ascertain the game's significance and meaning to its participants. This requires more than tracking just the game's component parts. I can preserve the client and server software used by *Second Life*, the database which tracks objects' location and ownership in-world, the modelling, texture and script files for objects in the virtual world, while still losing the majority of

the information about what people *did* in those worlds. To insure that we can continue to understand not just how a game functioned, but how it was used and what it meant, we must preserve information above and beyond the game itself.

Direct documentation of a game's use is one of the most important forms of information we can preserve. Fortunately, the gaming community excels at producing this. Screenshots of *Second Life*, videos of raids in *Warcraft* and websites documenting Guild activity, speed run files that users record of their quickest passes through levels in *Doom*, all of these provide information about game use and gaming culture that will assist scholars in interpreting these games in the future. Fortunately for game preservationists, all of these are readily available on the web today to add to their collections.

There are other forms of contextualizing information that may assist future scholars in interpreting games. Scholarly writings on games are one obvious source. Platform studies on systems such as the Atari 2600 (Montfort & Bogost, 2009) and digital humanities works on games such as Nick Montfort's (2005) and Dennis Jerz's (2007) examinations of *Adventure* provide vital information about games' history and evolution. Another, often overlooked type of contextual information for games is the physical packaging and documentation that accompanies the game (including the licensing terms covering the game's use). This provides important information on how a game was marketed and promoted, and on occasion proves vital to basic technical accessibility of a game as well. One of our project team was stymied for months while attempting to play an old version of *Where in the World is Carmen Sandiego?* as the copy we acquired on the secondary market proved to lack the encyclopaedia that shipped with the original, an encyclopaedia that provided keywords necessary to access portions of the game.

The problem of ensuring the social interpretability of games is therefore not typically one of a lack of information, but of an overload. Selecting among the numerous sources of information on-line and in print can be daunting. It also puts anyone interested in preserving games in the position of having to simultaneously preserve a variety of digital and non-digital ephemera. Critically, it requires that metadata linking all these items exists, so that both scholars **and** preservationists will be aware of the existence of all of the relevant material for a given game. This type of description is more akin to archival description, with its emphasis on collections, than it is to traditional library description.

I have already mentioned licensing information as being important contextual information for the preservation of games. Intellectual property rights and permission provided some of the most difficult issues for our project and in some cases these proved insoluble. Modern games are highly complex, composite artefacts, and any given game may have many rights holders controlling different assets within the game. Microsoft may hold the intellectual property rights to *Halo*, but it does not hold the intellectual property rights for all of the music contained within the game; most of it is used under license from the musicians who created the music.

Second Life provides an extreme example of complex ownership, as each user retains copyright over any object they create inside *Second Life*. This combined with the terms of service for *Second Life* (which dictate that you may not copy another user's intellectual property without their explicit permission) mean that any attempt to make a preservation copy of an island in *Second Life* must start with obtaining the permission of all of the intellectual property owners for any object in that island. While our project experimented with this approach, it resulted in at best a 10% response rate from copyright holders. The ability to preserve 10% of a game's content is something like being able to preserve 10% of a book; it may be better than nothing, but it is a good deal less than perfect.

Within the United States, current intellectual property law poses additional obstacles to preservation of some games. The Digital Millennium Copyright Act (DMCA) made it illegal to defeat a technological protection measure on digital media, even to make a preservation copy of a work. Digital media have extremely limited life spans; if a game cannot be legally transferred from its original media, its likelihood of survival is extremely low.

In theory, the DMCA's restrictions are not necessarily an absolute impediment to preservation activity on computer games. If the rights holder for a computer game is willing to grant permission for an archive to make a preservation copy of a work, despite the presence of a technological protection measure, the DMCA restriction is moot. Unfortunately, there is a significant orphan works problem in the world of computer games. While the vast majority of computer games are clearly still under copyright protection, identification of the rights holder can be a monumentally difficult, and occasionally impossible, task (Swalwell, 2009). Without a rights holder with whom to negotiate, libraries, archives, and museums are helpless to make preservation copies of protected games or transfer them to new media. The combination of issues involving complex (and occasionally unknown) ownership of intellectual property rights, restrictive licensing terms, and strong protection for technological protection measures can make it difficult or impossible to preserve some digital games.

Other problems our project encountered resulted from trying to apply developing models for digital preservation to gaming materials, in particular the Open Archival Information System (OAIS) Reference Model (CCSDS, 2002). One of the key insights of the OAIS Reference Model was that preserving a piece of digital information requires preserving not only the digital bit stream, but also the ability for a human being to decipher the meaning of the bit stream. To ensure this, the OAIS Reference Model dictates that in addition to the bit stream, an archive should also keep and preserve what it calls representation information, the information necessary to interpret a string of zeros and ones as meaningful data. Representation information includes both structure information, which maps bit sequences into basic data types (e.g., characters, pixels, numbers), and semantic information that establishes the context for interpreting the basic data (e.g., that a number represents the number of lives a player has at the beginning of a game).

The OAIS Reference Model states that representation information is part of the content information that must be preserved as part of an Archival Information Package for an object of preservation. If I wish to preserve the FORTRAN IV source code file for the game *Adventure*, I should therefore also be preserving a copy of the character set standard used to record the textual information (e.g., in our case, ISO/IEC 10646) as well as the PDP-10 FORTRAN IV Programming Manual documenting the syntax and semantics for that version of the FORTRAN language. Preservation of digital information is therefore just as much a process of preserving standards documents as it is preserving the original object of preservation.

It is the rare standards document, however, which can be interpreted without consulting other standards. A data standard like the PDF specification, for example, incorporates various other standards to control aspects of the format such as compression or colour space. The full set of representation information necessary to decode a particular piece of data can quickly begin to resemble a small technical library. The OAIS Reference Model recognises this dilemma, and allows an archive to limit the set of representation information it stores to the minimum necessary for the Designated Community the archive serves to independently understand the data object. One of the responsibilities of

an Open Archival Information System is to assess the knowledge base of its designated community on a regular basis to determine the level and extent of representation information that needs to be preserved along with a data object.

In the context of a scientific data archive (the original target for the OAIS Reference Model), where the members of the designated community (research scientists) can be assumed to be at least somewhat technically literate and have roughly consistent levels of technical knowledge, this is a reasonable approach to ensuring the interpretability of data in the long term. In the context of an academic library preserving computer games, it is extremely problematic. The ‘designated community’ for the University of Illinois library system is incredibly diverse, containing individuals with vastly disparate levels of knowledge and skill in dealing with digital data. Should the University Library collect the representation information necessary to support its least technical users, in which case the quantity of representation information needed will be immense? And if it does not, how will it ensure access in the future to those users?

One final problem with regards to representation information deserves mention. As mentioned previously, standards documents for file formats and the operation of computer hardware (e.g., instruction sets for computers’ processor chips) are a critical part of the representation information needed for software preservation. If one wishes to preserve a game like *Adventure* in its original FORTRAN IV source code incarnation, you should preserve a copy of the Digital Equipment Corporation’s FORTRAN IV language specification (Digital Equipment Corporation, 1969) to document the source code’s semantics.

The good news is that many research libraries already collect these types of standards documents. The bad news is that given current bibliographic practices in the United States, no one is ever likely to discover that fact (or those standards). A search in WorldCat, OCLC’s shared cataloguing database, for the title term “multimedia” and the author “International Organization for Standardization” results in a result set of 37 records covering a variety of ISO standards including sections of ISO/IEC 11172 (MPEG-1), ISO/IEC 13818 (MPEG-2), ISO/IEC 14496 (MPEG-4), and ISO/IEC 21000 (MPEG-21). However, of the thirty-seven standards documents present in WorldCat, only six records list holdings at libraries in the United States, and of those six, two are for draft versions of standards documents, not the final published version. Are research libraries in the United States utterly bereft of standards documents?

The answer is ‘no.’ Many research libraries hold standards documents. However, they do not make bibliographic records for those items publicly available. Grainger Engineering Library on the University of Illinois at Urbana-Champaign campus, for example, holds shelf after shelf of technical standards from the International Organization for Standardization, the Society for Motion Picture & Television Engineers and other standards bodies. But a search by a typical end-user of the library catalogue will not reveal any of those standards documents. Standards documents are often quite expensive; they are vital information sources for certain technical fields; and they also are often loose-bound and therefore difficult to tag with security strips. In short, they are perfect candidates for theft. As a result, most research libraries do not go out of their way to advertise their collections of standards documents.

While this is understandable, it presents the preservation community with a serious dilemma. Standards documents are vital to digital preservation, yet libraries try their best to limit widespread knowledge of their holdings of these materials. Unless research libraries develop procedures that allow them to more widely advertise their holdings of standards documents, digital preservation work will be severely impeded.

Preservation of computer games thus presents a large number of problems, and many of these problems have a significant metadata component. To preserve games, we need to be able to:

- clearly define the boundaries of digital objects and express links between them;
- precisely identify digital objects, particularly with respect to versions;
- link an object with related materials necessary to contextualize that object;
- document complex intellectual property rights situations; and
- identify representation information needed to decode an object, and link to available copies of that information.

While there are a number of metadata standards in place that support some of the above requirements, our project needed to address all of them, and preferably in a manner that builds on existing standards already in use in the library and preservation communities.

The Wisdom of OWL

As the requirements above make clear, game preservation not only requires a substantial amount of metadata, it requires metadata of a variety of types. Clear identification of content is the goal of descriptive metadata standards such as MARC/XML or Dublin Core. Establishing the boundaries of a digital object and enabling links between materials is the province of structural metadata standards such as METS and OAI-ORE. Recording intellectual property rights information is the domain of administrative metadata standards like the Open Digital Rights Language and the Creative Commons Rights Expression Language.

There are a large number of existing standards for metadata in place within the library, archives and museum communities for different forms of metadata. Our project had no wish to invent new metadata formats when existing formats would do. However, existing standards by themselves did not provide a complete solution to the problem of metadata for game preservation, particularly with respect to the problems of carefully delineating versions of materials and providing clear links to other objects. We needed a data model for preservation description of materials to guide our use of existing standards.

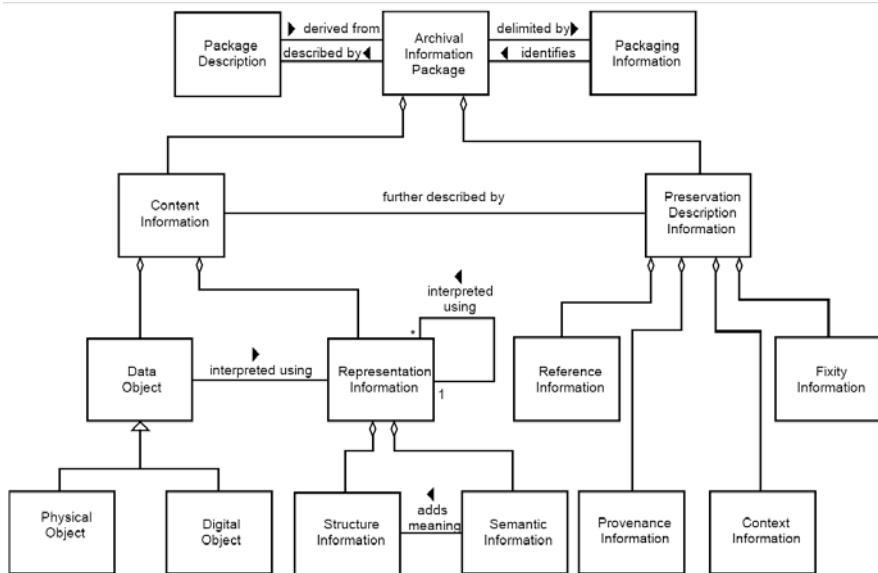


Figure 1 - OAIS Reference Model Archival Information Package

The Open Archival Information System (OAIS) Reference Model provides the beginning of the data model in its description of an Archival Information Package (AIP) (CCSDS, 2002, 4-18 – 4-47) (See Figure 1). An AIP contains both the data object to be preserved along with the representation information to decode that object, and preservation description information that includes documentation of the system of identification used to refer to the content within the object, fixity information used to confirm that a digital object has not undergone unauthorized change, provenance information and context information. This data model addresses several of the key requirements we identified previously, but does not provide support for identification of versions of material necessary for game preservation.

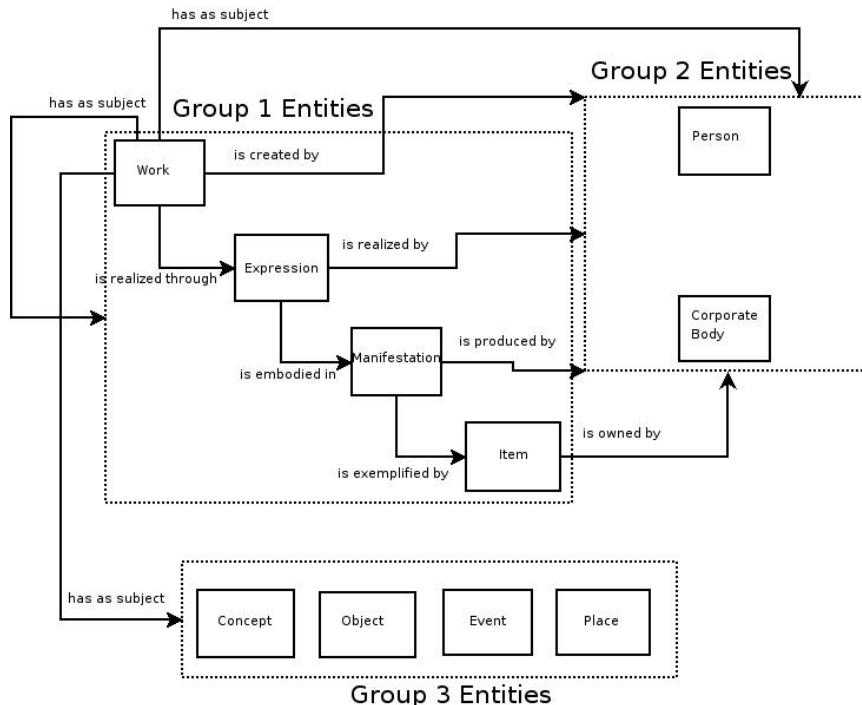


Figure 2 - FRBR Entity-Relationship Model

Fortunately, the entity-relationship model developed by the International Federation of Library Associations and Institutions in its *Functional Requirements for Bibliographic Records Final Report* (Madison et al., 1997) provides the support needed (See Figure 2). This model employs four entities to depict intellectual and artistic creations: the *Work* (a “distinct intellectual or artistic creation”), the *Expression* (the realization of a *Work* in some form), the *Manifestation* (the physical embodiment of an *Expression*), and the *Item* (a single exemplar of a particular physical *Manifestation*). A *Work* may have one or more *Expressions*; the game *Adventure*, for example might be realized in both a FORTRAN language *Expression* and a C language *Expression*. A given *Expression* may be embodied in more than one physical *Manifestation* (the same FORTRAN version could be recorded to both an optical disc and to a magnetic disc), and a particular *Manifestation* may exist in multiple copies (*Items*). The FRBR entity-relationship model was developed by the library community to support the fine-grained identification and description of editions of works needed for scholarly research, and thus enables the identification of versions needed by our project.

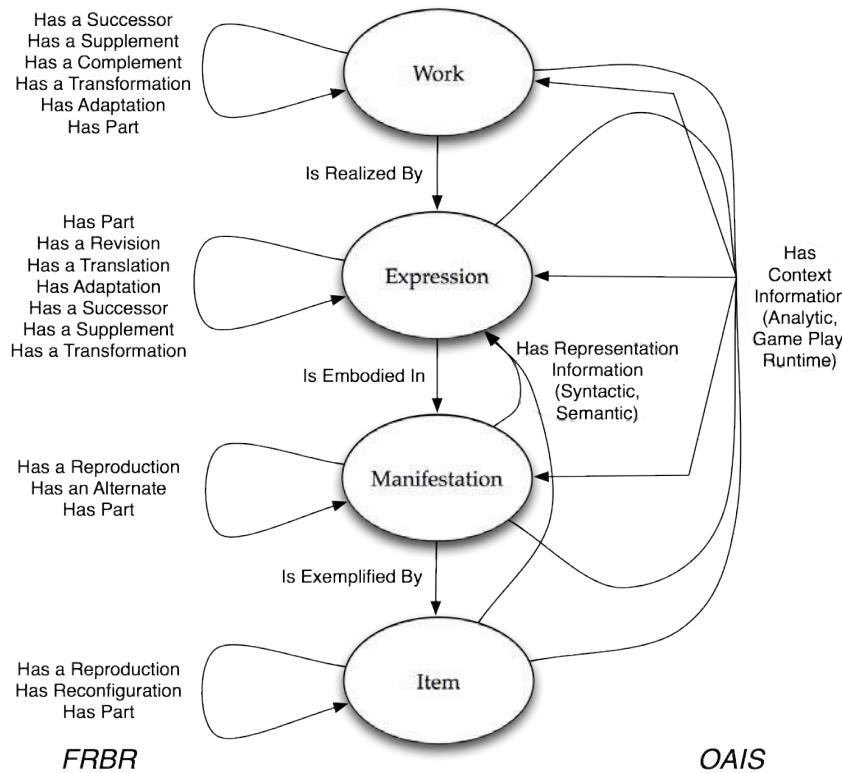


Figure 3 - Preserving Virtual Worlds Ontology

To meet the requirements for metadata for game preservation, what we needed was a mechanism for merging these two data models and to use the results in conjunction with existing metadata standards to describe the games in our case set. We achieved this by creating an ontology in the World Wide Web Consortium's OWL ontology language that used the FRBR entities depicted in Figure 2 as classes. Specific relationships between those entities, whether deriving from the FRBR entity-relationship model or the OAIS reference model, were set as properties for those classes. So, in addition to asserting standard relationships within the FRBR model (e.g., an *Expression* is embodied in a *Manifestation*), we might also assert OAIS relationships using FRBR entities as classes (e.g., a *Manifestation* has as representation information an *Expression*). Figure 3 shows a graphic depiction of our OWL ontology and the FRBR and OAIS relationships it establishes between the FRBR classes.

A formal ontology allows us to use existing structural metadata standards like OAI-ORE and METS, but in a way that conforms to our new data model and thus fulfills the requirements we have established for preservation metadata for computer games. Taking the case of the game *Adventure*, we might create separate OAI-ORE resource map files for *Adventure* as a FRBR *Work*, an *Expression*, a *Manifestation*, and an *Item*. Each of these OAI-ORE aggregations would aggregate the OAI-ORE aggregation representing the next level down in the FRBR hierarchy, e.g., the *Work* aggregation includes the *Expression* aggregation, which in turn includes the *Manifestation* aggregation, etc. Each OAI-ORE resource map could include additional metadata appropriate to that level of the FRBR hierarchy. If a new *Expression* of *Adventure* is to be included in our Archival

Information Package, we can simply create a new OAI-ORE resource map for that aggregation (with new subsidiary *Manifestation* and *Item* resource maps as appropriate), and add that *Expression* aggregation to the existing *Work*-level aggregation. Separate

OAI-ORE aggregations could be created for digital content being used as representation information and context information, and appropriate links created in the aggregation

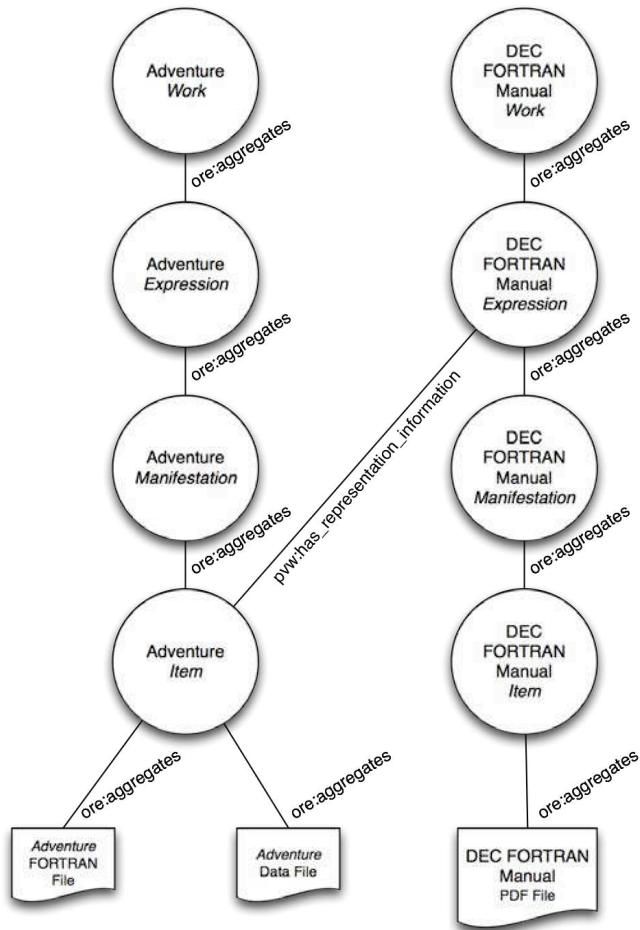


Figure 4 – Modelling Adventure

resource map files using the terms from our ontology.

Graphically, we might depict the case of *Adventure* as we see in Figure 4. We have separate OAI-ORE aggregations for each level of FRBR hierarchy for all of the intellectual objects being stored in our repository. Each OAI-ORE aggregation has its own resource map file providing appropriate descriptive metadata about the object for that level, and which can also provide links to other objects as appropriate. Here we see the OAI-ORE vocabulary terms being used to indicate the links between FRBR levels and “has_representation_information,” a term from the Preserving Virtual Worlds ontology, used to link the *Item* level aggregation for the game *Adventure* to the *Expression* level aggregation for the DEC FORTRAN programmer’s manual. While the encoding details obviously vary, this same model of the objects for *Adventure* can be created using the METS metadata standard or any other structural metadata standard capable of following the RDF data model.

A Few Remaining Problems

The combination of an OWL ontology with existing metadata standards provides us with a suitable mechanism for recording metadata for the preservation of computer games. However, based on our experiences in actually packaging games for long-term preservation in the Preserving Virtual Worlds project, this solution raises several new problems that need to be addressed. These problems include that of creating the metadata needed for game preservation, and enabling appropriate access to that metadata.

The metadata creation problem is simple in nature, but may prove difficult to solve. Creation of an archival information package conforming to the model we have proposed involves generating significant amounts of metadata for even the simplest case. Figure 5 below is a visualization of the RDF graph created from the OAI-ORE resource map files we created for a single game, the early text adventure game for Apple II *Mystery House*. It should be noted that *Mystery House* is an extremely simple game by modern standards, and we have included the absolute minimum of representation information and context information for this game. The OAI-ORE resource map files were created manually in the Oxygen XML editor, and their creation took several days worth of effort after the necessary files had been located and acquired. Creating archival information packages in this manner is simply not a scalable solution, particularly when you consider that a modern game, such as Warcraft III, may include thousands of files, all of which require description (including representation information links). If game preservation is to be conducted on a large scale, vastly improved tools for metadata creation are necessary.

Research also needs to be done on how to present these vast webs of information to users within an archival context. The RDF model utilized by our project lends itself to the linked open data paradigm being pursued by many libraries and archives in the higher education realm (Hawtin, Hammond, Miller & Matthews, 2011). But this web of data presents at least some difficulties for users trying to make sense of archival holdings. A user interested in the content of a game archive probably does not want to be presented with the entirety of the web of metadata seen in Figure 5 below, but rather an appropriately abridged version. Curators would presumably require a somewhat different view of this metadata. At this point, we do not really understand the issues involved in framing these webs of data for user consumption, but certainly neither the raw XML nor visualizations such as the above are going to be of much use to end users.

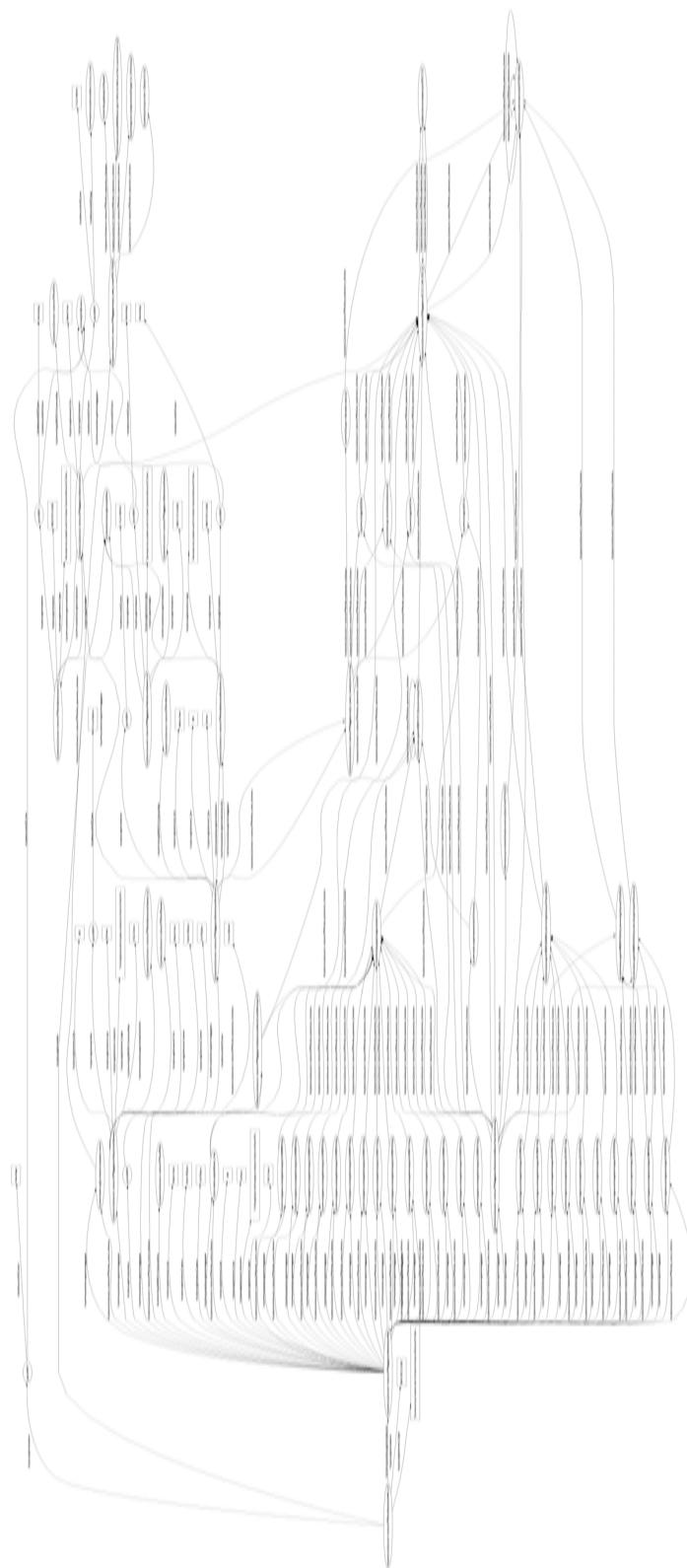


Figure 5 – RDF Graph for *Mystery House* Package

Technologies such as SPARQL (W3C, 2008) provide a mechanism for selecting portions of this web, but how best to use such mechanisms for viewing and managing archival collections of game materials is an issue that will require much more exploration.

Computer games are some of the most complex digital creations in existence, technically, legally and intellectually. They are also arguably the first major new form of media to come along since the creation of television and have achieved a great deal of economic and cultural significance. Preserving these new artworks of the digital era is critical, but if they are to survive, the metadata systems used by librarians, archivists and curators will need to undergo significant change.

Acknowledgements

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Metadata for Preserving Computing Environments

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c/o The British Library, Floor 5, Room 14, 96 Euston Road, London NW1 2DB Metadata for Preserving Computing Environments

Abstract. Metadata is information about an object that is needed in order to manage that object. Preservation metadata for computing environments is the information that is needed in order to successfully redeploy computing environments in some form in the future. This chapter introduces approaches for defining preservation metadata for computing environments.

Introduction

Metadata is information about an object that is needed in order to manage that object. Preservation metadata (Dappert, Enders, 2010) for computing environments is the information that is needed in order to successfully redeploy computing environments in the future. Metadata for digital objects' computing environments constitutes essential representation information that is needed in order to be able to use digital objects and to make them understandable in the future. This is why metadata about computing environments must be preserved together with the digital objects as part of their core metadata. Furthermore, software components themselves may be the primary objects of preservation, and require a metadata description. Computer games can take either of these two roles.

Digital objects and the computing environments in which they function are continuously under threat of becoming unusable through deterioration, obsolescence, or inadvertent damage during form or environment shifting. Computing environment preservation can happen, for example, through hardware and software preservation, emulation, reconstruction, or porting to new environments. Depending on the nature of the computing environment, the nature of threats, the preservation approach and the community that wants to redeploy the computing environment, different metadata is needed.

The TIMBUS project (TIMBUS project, 2012), a 3-year EU co-funded project, addresses the challenge of long-term digital preservation for business processes and services. This entails the preservation of computing environments. It entails definition of metadata needed to access processes and their computing environments in the long run. This chapter introduces the TIMBUS approach, illustrates how it can be applied to the preservation of computing environments, and describes other efforts for defining metadata for preserving relevant aspects of computing environments. TIMBUS goes beyond the preservation of computer games and virtual worlds, but it is easy to see how the same approach can be used for them.

The TIMBUS Project

The EU co-funded TIMBUS project addresses the challenge of digital preservation of business processes and services to ensure their long-term continued access. TIMBUS analyses and recommends which aspects of a business process should be preserved and how to preserve them. It delivers methodologies and tools to capture and formalise business processes on both technical and organisational levels. This includes the software and hardware infrastructures underlying these business processes and dependencies on third-party services and information. TIMBUS aligns digital preservation with well-established methods for enterprise risk management (ERM), feasibility and cost-benefit analysis, and business continuity management (BCM).

TIMBUS explores this challenge with three scenarios: engineering principles for digitally preservable services & systems, civil engineering infrastructures, and eScience and High Energy Physics.

It is executed by a consortium of industry, research and SME partners from across Europe. This involvement of industry is a sign that awareness of the need for preserving digital objects over the long-term is spreading from the traditional champions in memory institutions and heavily regulated private sectors, such as pharmaceutical and aircraft, to the general private sector.

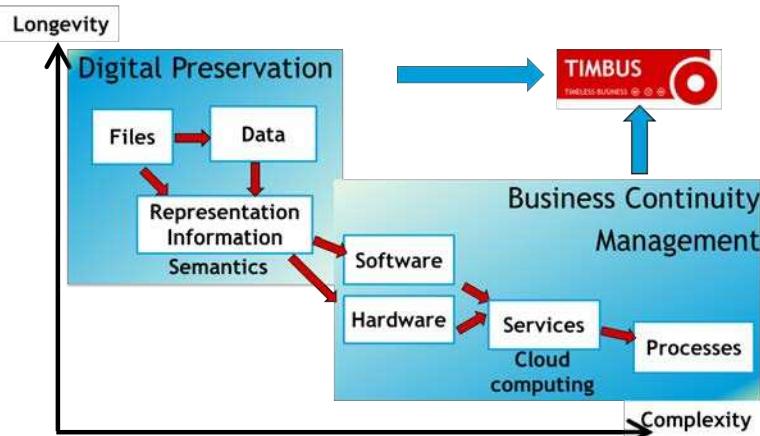


Figure 35: Digital Preservation and Business Continuity Management

This growth of awareness about the need for developing sound digital preservation methodologies and tools is accompanied by a growth in complexity of the digital objects that need to be preserved. Figure 1 illustrates the relationship between the fields of digital preservation and business continuity. The horizontal dimension expresses the degree of complexity of the digital objects that need to be preserved and the vertical dimension expresses the degree of concern for the longevity of the digital object. The digital preservation community has initially focused on relatively simple objects, such as image files or documents, with a clear long-term access need. This was followed by scientific data held in databases and basic representation information that captures the semantics of files and data so that they can be interpreted in the long-term. Obviously, these “simple” digital objects sometimes are actually quite complex, especially if they contain embedded and linked digital objects or if there is a multitude of rare or customized file formats. Similarly, the representation information quickly becomes very complex, if one seriously thinks about preserving the underlying software and hardware that are needed to access a digital object. The situation becomes even more complex if there are dependencies on

third parties, such as in service and licensing models, especially in the Cloud, where data and software may be outside the repository's immediate control, or if there are distributed computing environments. With increasing complexity and in the presence of non-digital preservation objects, such as hardware or processes, the actual object of preservation cannot always be digitally preserved; instead sufficient descriptions of the object and its significant characteristics need to be captured in metadata to enable future re-deployment. For example, hardware and business processes are not preserved directly, but their descriptions are.

Business Continuity Management (BCM) (Burtles, 2007), as a discipline, has focused on the lower, right quadrant. Complete processes, including services and whole computing environments need to be kept running. But, traditionally BCM has dealt with immediate disaster response rather than with long-term aspects of digital preservation.

The TIMBUS project is shifting the emphasis into the upper, right quadrant, where it deals with the long-term preservation of complete processes and their computing environments. It tries to combine approaches of digital preservation with those of enterprise risk management and business continuity management and investigates digital preservation need and potential in those new application areas.

The commercial imperative for business process preservation comes from several pressures. Heavily regulated industries, such as pharmaceuticals and aircraft manufacture must fully document processes so that they can be audited, reproduced, or diagnosed. This provenance information may be used as evidence in the case of litigation. Long-lived companies must manage services across multiple changes in technical environments; they may need precise process specifications to reproduce functionality on a new platform. If processes are outside an organization's control, such as in service and licensing models, especially in the Cloud, they may use an escrow service in order to mitigate the risk of losing access to the data or services they depend on. They must be confident that all of the necessary information is demonstrably included in the escrow agreement and services. This problem is isomorphic to the digital preservation of software. Organisations undergoing major staff changes must ensure that they retain the knowledge needed to operate or re-instate production processes.

In addition to publications and data, scientists need information about the software and processes that produced them to assess the validity of the data and the derived scientific claims. The same provenance information that can provide a key in regulated industries can also support credit assignment in academia. Process information provides a form of provenance metadata, which documents stewardship and the events that have impacted the resulting process products. This information is generally important to prove the authenticity or quality of process products. All industries benefit from analysis of processes that may lead to their continuous improvement. There is an example illustrating this latter use case later in this chapter.

1. The TIMBUS Approach

TIMBUS breaks business process preservation down into three functions:

- The *Planning* function performs risk analysis and determines the requirements for preserving the relevant business processes. It employs reasoning-based Enterprise Risk Management to identify preservation risks, to assess their impact, to identify mitigation options and to determine the options' cost-benefit. This is integrated with a three-fold analysis:

- *Determine the relevant process context:* What are the parts of the process and its environment context that need to be captured so that one is able to redeploy the process in order to successfully mitigate the risk?
- *Determine dependencies:* What are the dependencies of these relevant process, object, software and hardware components to other process, object, software and hardware components in this context?
- *Determine legal and regulatory restrictions:* What legislative, regulatory or licensing considerations impact the ability to preserve now or to redeploy later the context components that should be preserved?
- The *Preservation* function virtualises the business processes and services together with their computing environments and relevant business documentation and preserves them appropriately. This includes third-party and distributed services. It also validates the preserved process to ensure that it enables the redeployment of all significant functionality of the original process.
- The *Redeployment* function reactivates and reruns the business processes. For testing purposes, this process is integrated with a testbed in which future potential scenarios are simulated. In the testing phase redeployed processes also are verified against the significant characteristics (Dappert, 2009) of the original process.

2. Example Preservation of a Business Process

This section illustrates the TIMBUS approach by introducing an example process and applying several of the TIMBUS preservation planning steps. The process in case is a migration process: An organisation holds millions of images in the rather bulky TIF format. Management decides that it would be preferable to migrate the files to a more compact file format in order to save on storage cost.

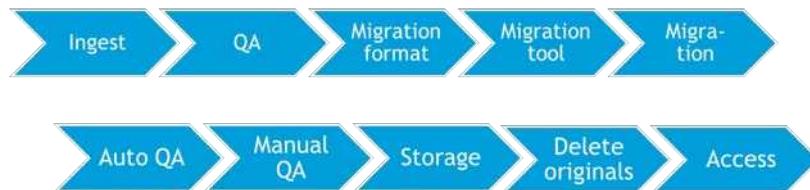


Figure 36: Example migration workflow

A typical process for solving this task might consist of the steps illustrated in Figure 2. Following ingest of the original TIF files, a quality assurance step ensures that the ingested files are not damaged. The project team has to decide the best migration target file format and optimal configuration parameters, degree of lossy-ness, etc. based on the characteristics of the files. They chose the best tool suited to this migration task and perform the actual migration. This is followed by an automatic quality assurance step, and, since not all problems can be detected automatically, by a manual quality assurance step on a sample file set. The files are now stored, possibly over the course of decades. This may entail a need for data carrier refresh, copying to new locations, and other preservation and administration tasks. The original files are deleted and the new files are made available for access.

The team would like to preserve the process in order to provide provenance information to future users that documents what changes have been performed to the

original files. They also want to preserve the process, so that, should one later discover defective files, one could diagnose what part of the process may have caused this problem. This is part of their continuous improvement task. The diagnosis allows them to avoid repeating the same mistake in similar processes.

In order to determine which preservation metadata is needed to later successfully redeploy or diagnose the process, TIMBUS uses the 4 basic techniques discussed earlier (manage risks, determine the relevant process context, determine dependencies, determine legal and regulatory restrictions).

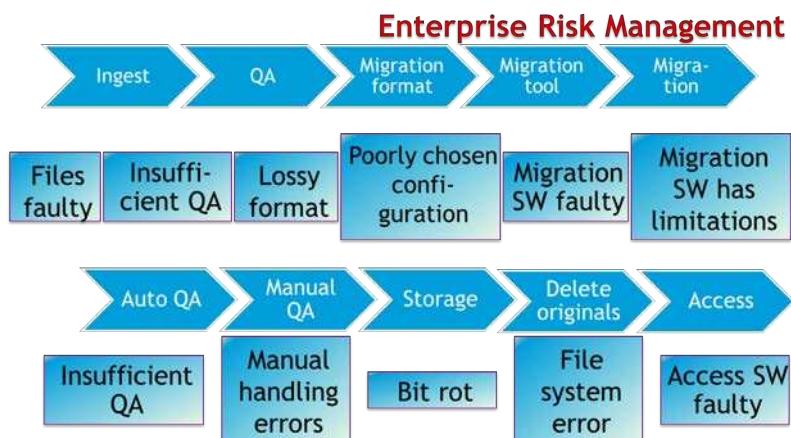


Figure 37: Example risks

Manage risks: The Enterprise Risk Management task might identify the following risks (Figure 1): The original received files may be faulty, the quality assurance steps may be insufficient, the new file format may be too lossy, the configuration parameters of the new file format may be chosen poorly, the migration software may be faulty or limited to a subset of files (for example of a limited file size), there may be manual handling errors, the files may be affected by un-mitigated bit-rot, there may be file system errors, or the newest rendering software in use may not fully implement the file format standard and render the files in a way that they appear corrupted even though they are actually not at all damaged

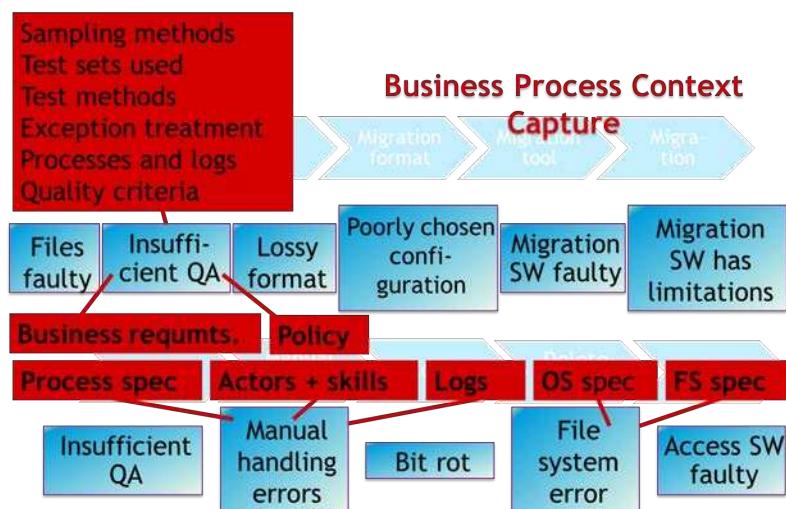


Figure 38: Example context

Determine the relevant process context: Each risk is related to a subset of the process metadata that is needed to redeploy or diagnose the affected process steps. The context capture step might, in this example (Figure 4), determine that one would have to capture the following metadata in order to mitigate the risk of “insufficient quality assurance”: the sampling methods applied, the actual test sets used, the test methods used, the exception treatment applied when problems were detected, process descriptions, logs and quality criteria applied. Additionally one might want to know the business requirements that drove the quality assurance step and the policies underlying it. For the risk of “manual handling errors” one might wish to know the manual process steps, who were the actors, what training they had received and what processing logs were created. This illustrates that context components can be quite varied: process steps, software components, hardware components, virtual machines, networks, configurations, objects, documents, business requirements, etc.

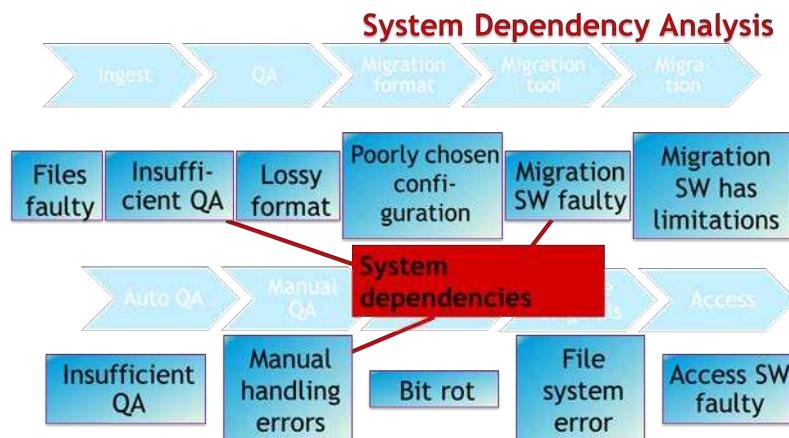


Figure 39: Example dependencies

Determine dependencies: In addition to identifying the relevant context components one has to determine which dependencies exist from the identified context components to other context components. The ones relevant for process redeployment need to be identified. For example, in Figure 5, software used during the quality assurance step, the migration, or the manual quality assurance may depend on hardware or secondary libraries.

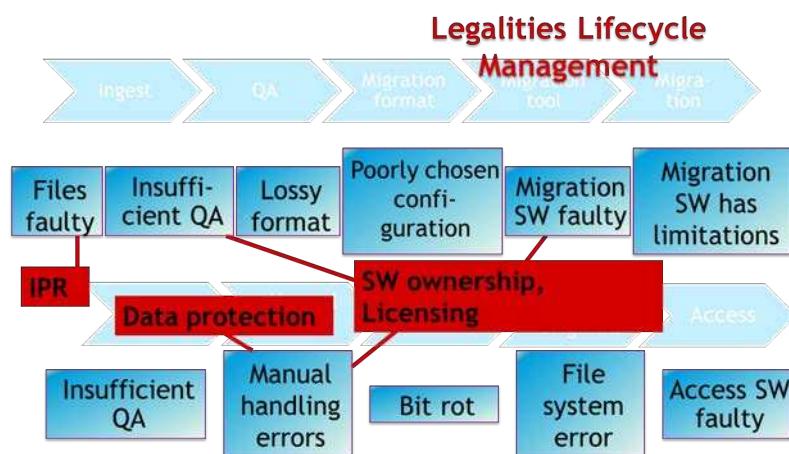


Figure 40: Example Rights Restrictions

Determine legal and regulatory restrictions: Finally, legal or regulatory restrictions have to be captured for each process step that has been determined to be relevant during risk assessment. It is necessary to determine which preservation actions can be legally performed now and which restrictions may exist in the future on use of the preserved process and its computing environment. In the example (Figure 6), software licensing issues may affect the preservation of migration software used; data protection issues may affect the information that can be preserved about the actors in the manual handling steps; and copyright issues may affect the preservation of samples of the original data.

Finally, the expected impact of the risks and the cost of preserving the context identified in this planning step need to be weighed against each other in order to derive the final preservation plan.

Metadata for Preserving Processes and Computing Environments

For each of these process description elements (processes, context, dependencies, regulations), suitable metadata definition has to be identified or created so that their descriptions can be captured in a uniform, repeatable manner. Their instances then need to be packaged, related to each other, and preserved for future re-deployment.

Much relevant metadata work has been done in the past and is being done now on subsets of this domain. When determining metadata for computing environments and whole business processes the results of existing work should be reused as much as possible. Some of it is discussed in the following sections.

1. Core Digital Preservation Metadata and Computing Environments

The PREMIS Data Dictionary (PREMIS, 2011), a de-facto standard, defines core metadata for the digital preservation of any kind of digital object. “Core metadata” is the metadata that is needed by most preservation repositories, rather than the application or content specific metadata defined for niche uses. Metadata for a digital object’s computing environment is needed in order to be able to use the digital object and to make it understandable in the future. Furthermore, software components themselves may be the primary objects of preservation, and require a metadata description. Additionally, a computing environment can take the role of an agent that executes a preservation action.

The PREMIS Editorial Committee has commissioned a working group in late 2011 to examine what computing environment metadata needs to be captured in order to describe computing environments in those varying roles and to be able to successfully redeploy digital objects and their environments in the long-term. The goal of the group is to rethink the metadata specification for computing environments so that their capture meets the improved understanding of how they should be described in order to ensure their longevity.

In version 2.2 of the PREMIS Data Dictionary (PREMIS, 2012), there are four key entities that need to be described to ensure successful long-term preservation of digital objects: Object, Event, Agent and RightsStatement. The Object entity provides two places to describe subordinate environments. For one, there is the “environment” semantic unit that permits the description of software, hardware and other dependencies. Rather than being an entity per se, an Environment is modelled as a semantic unit container that

belongs to an Object and is, therefore, subordinate to the Object entity. The second environment-related semantic unit is the “creatingApplication” that also is subordinate to the Object entity. Creating applications are outside the scope of an OAIS repository and have therefore been historically treated separately from other Environment descriptions. In a generic digital preservation framework that is not restricted to OAIS use, but supports the end-to-end digital preservation life-cycle, one would describe Environments uniformly, no matter in what context they are used.

Its subordinate position to Objects means that Environments can only be captured to describe an Object’s computational context. This has the following limitations:

- Environments are too complex to be handled in an Object repository.
- Environments are rarely specific to a single Object, resulting in their redundant spread across different Objects. This results in
 - unnecessary verbosity;
 - cumbersome management of Environment descriptions as they evolve.
- They are unable to describe stand-alone Environments and unable to be used for modelling an Environment registry that describes Environment components without the need for creating Objects.
- They are primarily applicable to computing environments and do not include representation information in the broader sense. This restricts the description to a technical level rather than to a level that comprehensively enables redeployment.

The working group’s use case analysis identified the five desirable relationships illustrated in Figure 7. Because Environments are subordinate to Objects, it is impossible to express the latter four of them.

1. An Object specifies its Environment, i.e. its computational context. This is the existing relationship in PREMIS 2.
2. An Environment (for example, games source code) is to be preserved as first-class entity in its own right. It takes on the role of an Object.
3. An Environment takes the role of an Agent (for example, as software Agent involved in a preservation action Event).
4. An Environment is related to another Environment through inclusion, dependency, derivation or other relationships.
5. An Environment has an Event associated with it (for example, a creation or versioning Event).

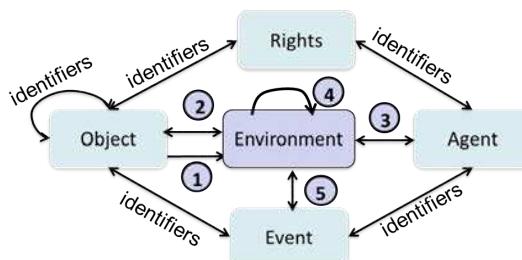


Figure 41: The basic entities of the PREMIS Data Dictionary (in blue) with the desired Environment entity and their relationships.

Another limitation is that in PREMIS 2, Environments are unable to refer to external dedicated registries, which would enable the delegation of "up-to-date and complete" information to an external source if needed. The identified shortcomings may be the reason that the Environment semantic container in PREMIS is rarely used.

A possible solution is to treat Environments as first class entities that do not have the limitations listed here. Treating Environments as first class entities also makes it more

natural to model preservation actions that directly impact Environments, such as data carrier refresh or emulation, as easily as preservation actions that directly impact Objects, say migration. This is particularly important for the preservation of computer games and other kinds of software. While describing those actions is possible with the PREMIS model in version 2, it is not doable in a very natural way (Dappert, Peyrard, Delve, Chou, 2012).

Version 3 of PREMIS will address these limitations and requirements and introduce an improved platform for modelling computing environments.

2. Software Preservation and Technical Registries

Specialised metadata has been defined to support the preservation of software. For example, “The Significant Properties of Software: A Study” (Matthews, McIlwrath, Giaretta, Conway, 2008; Software Sustainability Institute, Curtis+Cartwright, 2010) identified *Functionality, Software Composition, Provenance and Ownership, User Interaction, Software Environment, Software Architecture and Operating Performance* as basic metadata categories for software that could be applied on *Package, Version, Variant* and *Download* level. The Preserving Virtual Worlds project (McDonough et al., 2010), POCOS (POCOS, 2012), SWOP (SWOP, 2012) and DOAP (Dumbill, 2012) have also made proposals about preservation metadata needs for software preservation. Examples of software repositories, such as the NSRL (National Software Reference Library, 2012), MobyGames (MobyGames, 2012) and AMINET (AMINET, 2012) illustrate practically used metadata schemas, but do not necessarily support digital preservation functions. Likewise, Jhove (JSTOR, the Harvard University Library, 2012), PRONOM (The National Archives, 2012), UDFR (Unified Digital Format Registry, 2012a) and the Library of Congress (Library of Congress, 2012) have defined metadata that is needed to technically or qualitatively describe file formats and have built repositories based on their metadata descriptions. This includes some software metadata specifications, which, for PRONOM, are now available in a linked data representation and for UDFR contains software description in the UDFR database (Unified Digital Format Registry, 2012b).

Metadata that is used to capture complex dependencies is addressed in initiatives such as VRDF (Kadobayashi, 2010) which captures virtualized infrastructures, CDMI (SNIA, 2012) which “describes the functional interface that applications use to create, retrieve, update and delete data elements from the Cloud”, and the Web Service Definition Language (WSDL) (W3C, 2001).

The KEEP project on emulation (KEEP, 2012) designed a prototype schema for the TOTEM database (TOTEM, 2012) and is a recent move towards building a repository for describing the technical properties of computing and gaming environments including software and hardware components. Similarly, the IIPC (IIPC Preservation Working Group, 2012) has developed a technical database using a computing environment schema as a foundation for web archiving, and TOSEC (short for “The Old School Emulation Centre”) (TOSEC, 2012) “is dedicated to the cataloguing and preservation of software, firmware and resources for microcomputers, minicomputers and video game consoles.”

All of these initiatives are relevant for the preservation of gaming environments and virtual worlds. TIMBUS, additionally draws on metadata standards that capture business processes, such as BPMN (Object Management Group, 2011), and is defining other forms of supporting business documentation needed to redeploy processes and services.

Conclusion

When complex digital objects, such as computer games, virtual worlds or even complete processes and services need to be preserved, re-deployed and understood in future environments, a key task is to determine the metadata needed to support this goal.

Research has focused on specific environment metadata types, such as core preservation metadata, technical environment description, dependency descriptions and process descriptions. For complex objects it is necessary to identify the most suitable metadata descriptions available, to identify gaps that are not covered by existing approaches, and to determine the structural information that is needed to tie them together. This task should be driven by a thorough understanding of the components that make up the complex object's context, by risks and cost-benefits identified, by an understanding of the functions that are supposed to be supported through this metadata and expectation of future needs of designated communities. Based on this one can then develop preservation actions if the need is identified.

The challenge of preserving computer games and virtual worlds is connected to the challenge of preserving complete business contexts. TIMBUS is working to define metadata categories, models and methodologies for identifying relevant metadata. The essential foundations in preservation metadata have been laid by PREMIS and are being extended to better support this and other complex use cases.

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Preserving Games Environments via TOTEM, KEEP and Bletchley Park

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Abstract. This chapter explores several initiatives from the KEEP project that provide information to help preserve computer gaming environments, including the Trustworthy Online Technical Environment Metadata database, TOTEM, and the KEEP Emulation Framework as deployed at the Computer Games Museum (ComputerSpieleMuseum – CSM), Berlin, Germany. Also addressed is the related issue of hardware preservation, where collaboration with computer history museums such as the one at Bletchley Park is explored. Lastly, the parallel issue of the importance of software preservation for this area is stressed, with reference to the substantial contribution to this topic in the POCOS e-book on Visualisations and Simulations.

Introduction

Emulation has long been eschewed as a viable digital preservation (DP) strategy for mainstream memory institutions: it is seen as being possible in theory, but not actually practicable in real life preservation situations. It is not surprising then, that it took some lateral thinking to make inroads into the problem of bringing emulation to the fore as a viable DP strategy. To achieve this, the KEEP project included a somewhat eclectic mix of partners: traditional DP institutions such as national libraries, a computer games museum, and an academic partner with a background in computing history as well as games development and preservation. This rather unusual group has facilitated research and development into the use of emulation specifically to preserve, amongst other things, computer games: arguably some of the most complex digital objects for which memory institutions would expect to be responsible to preserve. In this chapter we discuss some of the tools and initiatives emerging from KEEP that support the preservation of computer gaming environments: including the Trustworthy Online Technical Environment Metadata database, TOTEM, and the KEEP Emulation Framework as deployed at the Computer Games Museum (ComputerSpieleMuseum – CSM), Berlin. Whilst these new tools make a significant contribution to the practice of emulation, and therefore DP overall, there are still unfamiliar areas into which the community needs to look. Whilst software preservation has been accepted as important by the DP community for some while now, as witnessed by the work of the Software Sustainability Institute and the STFC, hardware preservation has long been deemed to be unnecessary by proponents of both emulation and migration (see chapter two in (Delve & Anderson, 2012)). This stance has the unfortunate effect that the DP community could then miss out on much sterling work carried out at computer history museums worldwide that could bring them important benefits: indeed, were they to collaborate across these different domains, it could result in valuable sharing of knowledge (database of hardware), a plethora of computing resources (e.g. emulators) and documentation (e.g. manuals).

KEEP Games Initiatives

Emulation is well understood and practised by the computer gaming community, which is recognised as being at the forefront of developing emulators (e.g. the MAME (Multiple Arcade Machine Emulator) community¹ who have developed emulators for computer games arcades). This was a key part of the rationale for including the games community in the KEEP project. The KEEP Coordinator, the French National Library, has arguably one of the largest collections of preserved computer games of any national library, as they are mandated (uniquely in Europe, it would seem) to do so due to their national deposit laws obliging them to preserve computer games as cultural artefacts. Other KEEP partners include: the German Computer Games Museum (ComputerSpieleMuseum (CSM)), Berlin; the European Games Developers Federation (EGDF); and the University of Portsmouth with academics researching games development and preservation, the history of computing and digital humanities. The Digital Preservation SME Tessella, together with the Dutch National Library (the Koninklijke Bibliotheek (KB)), with their background in DP emulation (Dioscuri) were tasked with creating an Emulation Framework (EF), so that developers, particularly from the gaming community, could be aware that their emulators could be used in order to render old computer games for both the DP and the gaming communities. The University of Portsmouth created the GUI for the EF, as well as the TOTEM database comprising technical environment metadata to support the emulation process on the EF. We will start with a brief review of the KEEP findings on the difficulties of preserving computer games (Pinchbeck et al., 2009b) and (Anderson, Delve, & Pinchbeck, 2010).

Games environments Metadata: Background to the Challenge

The International Game Developers Association (IGDA) Special Interest Group on Preservation recently published a white paper detailing many of the specific issues facing game preservation. These include rapid obsolescence of both soft and hardware; media decay, access to material, legal constraints, lack of understanding or impetus, breadth of material surrounding any given title, and loss of cataloguing / descriptive information. They can be broadly grouped into three major problem areas: legality, cultural complexity and technical complexity. All of these require representation in any metadata schema aimed at the robust preservation of games.

In terms of technical complexity, migrating the quantity of code required to ensure runtime viability of a modern game is simply impractical (Pinchbeck et al., 2009a). Dondorp & van der Meer (2003) conclude that of Quake (id Software 1996) that “Rebuilding such a game is a gruesome operation that might easily compare to the complexity of emulation of the computing platform. To preserve highly interactive objects such as games, emulation is probably the only solution”. It is worth noting that they are referring to a game nearly 15 years old and thus comparatively simple by contemporary standards. Guttenbrunner, Becker, Rauber, & Kehrberg, (2008) present a case study on console video game preservation using the PLANETS preservation planning approach for evaluating both migration and emulation as preservation strategies in a documented decision making process. Their study included several different emulators and they conclude that emulation is well suited to preserving a variety of console games.

¹ <http://mamedev.org/>

Guttenbrunner (2004) argues that emulation at a hardware level is the ideal solution for console games. The split of emulators into hardware and software is one also made by Tijms (2000) and by Conley et al (2004), who describe a “window of opportunity” created by the lag in new console developments and PC hardware improvements that may even allow predictions to be made of when emulation technology will emerge for a given platform. Guttenbrunner, Becker, Rauber, & Kehrberg, (2008) consider challenges such as proprietary hardware and the lack of documentation as well as the wide range of media and also non-standard controllers.

The technical issues surrounding games preservation do not stop at code complexity. Subtle aspects such as minor alterations in processing speed can affect qualitative experience. Tijms (2000) notes there is not a direct correlation between the actual processing power of an emulated system and the requirements of the emulating system, due to specificities and peculiarities of the underlying hardware components of the former. Many games include middleware and DirectX components, and an increasing number rely on Internet connections for patches, updates and authorizations, some even requiring this to be active during play. Online multiplayer and LAN gaming all present further technical challenges, as in these instances it is not only a client-side emulation that is required, but emulation of the outlying environments with which the game may engage.

Equally problematic are the additional digital objects that develop around a commercial game. Lowood recognizes this when he states that “Capturing the history of community-generated content and the mod scene is a huge challenge, and it will require special attention to the variability and modifiability of software, including provisions for carefully documenting version history through metadata” (Lowood, 2004). We need to preserve not just a first or final version of an object, but its evolution through official patches and updates. But as well as these official add-ons, we need to ensure we are also ingesting unofficial fan-community work as well. To put this into context, we should remember perhaps that Counter Strike (Valve Software 2005), recognized as an important game in the history of online multiplayer shooters, spent its early life as a fan-community mod¹ of the commercial game Half Life (Valve Software 1998). Likewise, Media Molecule’s Little Big Planet (2008) is less a game than an engine for the construction and sharing of user-generated content. More discussion of associated objects can be found in Pinchbeck et al (2009a) and Lowood et al (2009).

Barwick (2009), Lowood et al (2009), Geiske (2002) and others have begun the process of understanding why games have been ignored by preservationists for so long, but at least the need is now generally recognized. However, the relatively late realization of what Gooding & Terras (2008) call the “current preservation crisis” facing games means that we are confronted with the task of either retrofitting the specific preservation metadata we can infer from the above, or creating new metadata structures that can be easily assimilated into existing schema. This introductory discussion makes clear that this specific metadata falls into three major areas not necessarily covered by existing schema:

Technical metadata is required to describe the original runtime environment, middleware, add-ons, and aspects of performance that may affect the experiential qualities of the game, such as sound capabilities, processor speed, data delivery from disc in run-time, video outputs, I/O devices, etc.

¹ Mods (or modifications) are common in the world of PC games. They can be quite extensive more or less constituting entirely new games in themselves, but require the user to have the original game release in order to run. They typically include new items, weapons, characters, enemies, models, textures, levels, story lines, music, and game modes.

Additional metadata and a robust network of associated objects (both games and other digital objects, such as video, audio, code, image and text) may be required to capture the cultural experience of a given game.

Legal information clearly describing the status of the disc image, runtime rights, and potentially legal status of embedded third-party requirements or associated material may be important given the highly charged nature of the field.

Game specific preservation metadata schema

Previously, only Karsten Huth's Master's thesis (Huth, 2004) attempted to develop a systematic, game specific schema. Current metadata on games tends towards simple cataloguing information, both in repositories and commercial/community sites such as MobyGames¹. Whilst the latter are clearly vital in the preservation of games, the information contained is both patchy and mainly descriptive: title, date, platform, sometimes system requirements. This falls a far short of the level of detail, robustness and interoperability required by repositories.

Commercial organizations such as PEGI, who maintain their own archive of games passing through the certifying process are in a similar state, holding descriptive data to catalogue the titles, but little complex metadata that would allow a runtime environment to be selected or recreated. A recurring issue with descriptive data schemes is classification by type or genre, which has generated a substantial quantity of literature. Dahlskog et al (2009) and Bjork & Holpainen (2005) have both proposed alternative approaches to classification for example.

Huth's solution is to draw from existing metadata schemas and supplement them with additional, self-generated, fields. The schemas he considers are:

- OCLC Metadata Elements (OCLC, 2003)
- Dublin Core Metadata Element Set (DCMI, 2003)
- Manual of Archival Description (Procter & Cook, 2000)
- DIN (German Institution of Standards) 66230
- Projekt Metadaten (DiGA, 2003)

Huth splits his fields into five groups: Representation, Reference, Provenance, Fixity and Context. Additionally, he restricts his work to very early systems: the Atari2600 and the Commodore 64 (one console, one computer). This means that his schema may not be particularly suited to dealing with some of the more complex issues noted above as it predates them considerably. For example, user-generated content in the form of community 'mod' culture (literally, modification of a commercial game that is freely available for users to distribute, usually with the support or at least blessing of the developer) only really began in earnest following the release of Doom (id Software 1993), as did network-based multiplayer gaming. Massively multiplayer online role-playing games (MMORPGs) such as EverQuest (Sony 2000) or World of Warcraft (Blizzard 2005) have their roots in the MUD systems first developed by Richard Bartle in 1991, but only really began to gather momentum in the late 1990s. However, even this falls nearly a decade after the C64's heyday.

In summary, Huth includes emulation and detailed run-functionality technical data. Of specific concern for preservation are: the complexity of the model and the consequent overheads of ingest; and cross-dependencies and object- extensions / alterations (in the

¹ <http://www.mobygames.com/>

form of patches, commercial extension packs, cracks and mods). Huth's work was instrumental in informing the development of the technical environment metadata necessary for preserving games in the KEEP project.

Games' Systems Requirements

These days systems requirements can be found on the back of games' back covers, and if these could be garnered routinely by publishers, and shared via a community-wide database or similar resource, this would be a real step forward. Such an approach is currently under ongoing discussion with a major publisher: a sound business case to make this viable for all concerned is needed to move this initiative forward. The systems requirements cover necessary versions of software, operating system and hardware (sound card, graphics card, computer), and often include both minimum and required specifications. This can cause a dilemma for the digital preservationist, who may not know which one to include, and additionally, abbreviations used are not always obvious (e.g. Windows Me – millennium edition).

Having identified these various sources of games environment data, the issue is now to incorporate them into a metadata model. The point to note here is that a robust technical environment metadata model needs to capture a fine level of granularity: it should show how a version of a game can run on a particular hardware platform (Commodore 64, Commodore 65 or Commodore 128). Similarly for a PC game – a specific version of the Operating System should be given (e.g. Windows 3.1) for a given PC, say x86. This level of granularity is not present in the excellent Mobygames site, which does have generic platform information and images of the systems requirements from the games' back covers.

Technical Environment metadata models

Within KEEP, a bottom up approach was used to develop data models that would capture the technical metadata required to describe the technical environment needed to emulate five different digital objects from the German National Library. The generic data model, Figure 1 also covers PC games (and also those for Apple II):

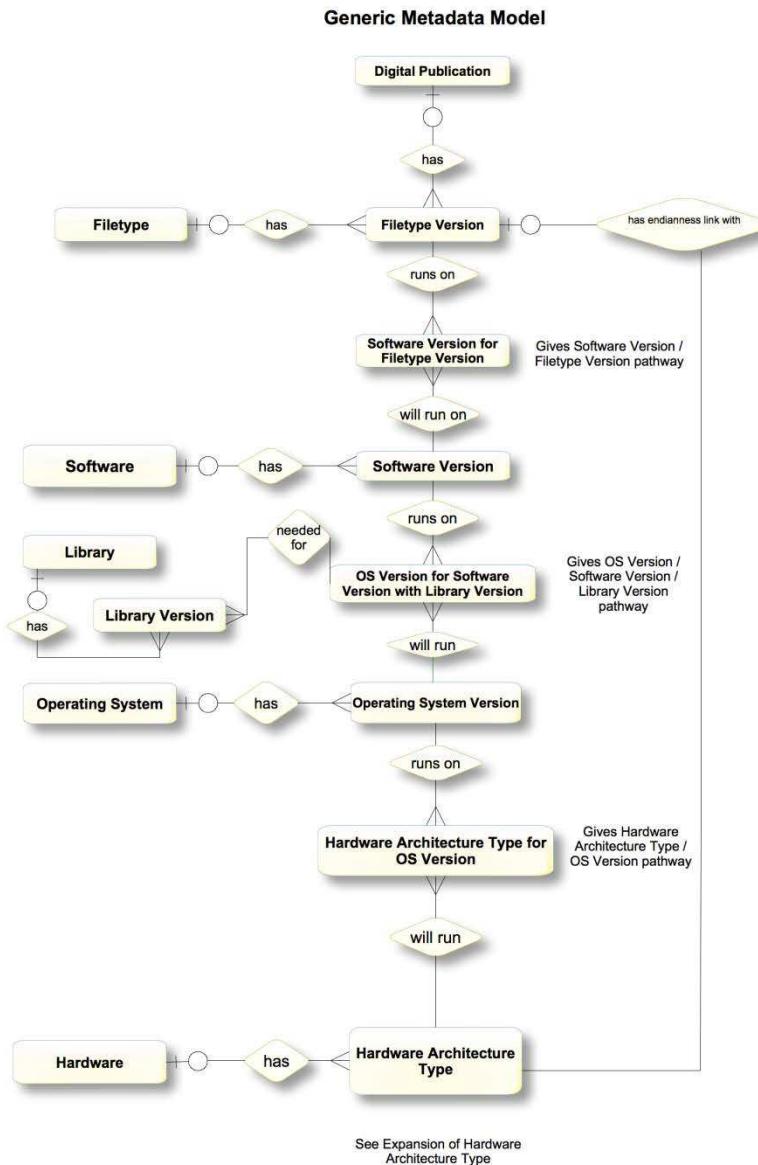


Figure 1. Generic data model.

This Enhanced Entity Relationship Diagram delineates the relationships between the elements of a typical computing environment stack, and the full attribute listing can be found in (Delve & Anderson, 2012). The Software Libraries attribute can also be used to contain details of Mods, Cracks, Extensions etc.

Similarly, the hardware part of the stack is given in Figure 2.

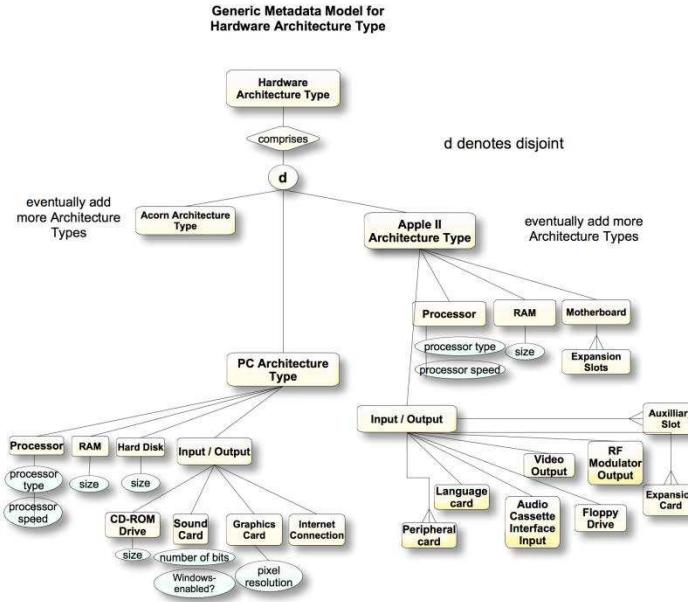


Figure 2 Hardware data model

However, when it comes to games consoles, it has to be borne in mind that they are fundamentally different in structural design from PCs as the operating system is not separate from the hardware as is the case with PCs. There are also many extra considerations to take into account in terms of the controller devices that are used with consoles: (joysticks, steering wheels etc.). Hence a separate data model was created in KEEP just for console games, as shown in Figure 3. Here much thought was put into creating a generic model that could cope with any type of controller, which could be analogue, digital (or both, as specified by the “o” for optional). So for an analogue controller like a joystick or steering wheel, input would be captured in terms of degrees of movement, planes of movement, number of controls and whether it was pressure sensitive or not. For a digital controller, the number of buttons would be recorded. This approach has been subjected to initial testing by a HATII PhD student and was found to fare well. More user testing is envisaged using whole games collections.

To go alongside the games, the C64 console was also modelled (Figure 4).

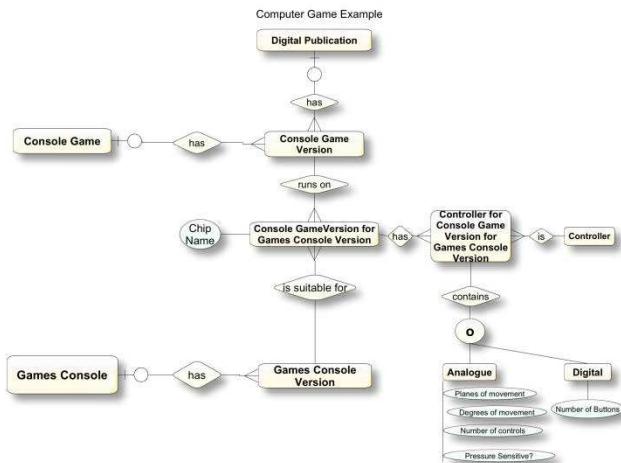


Figure 3. Console Games data model

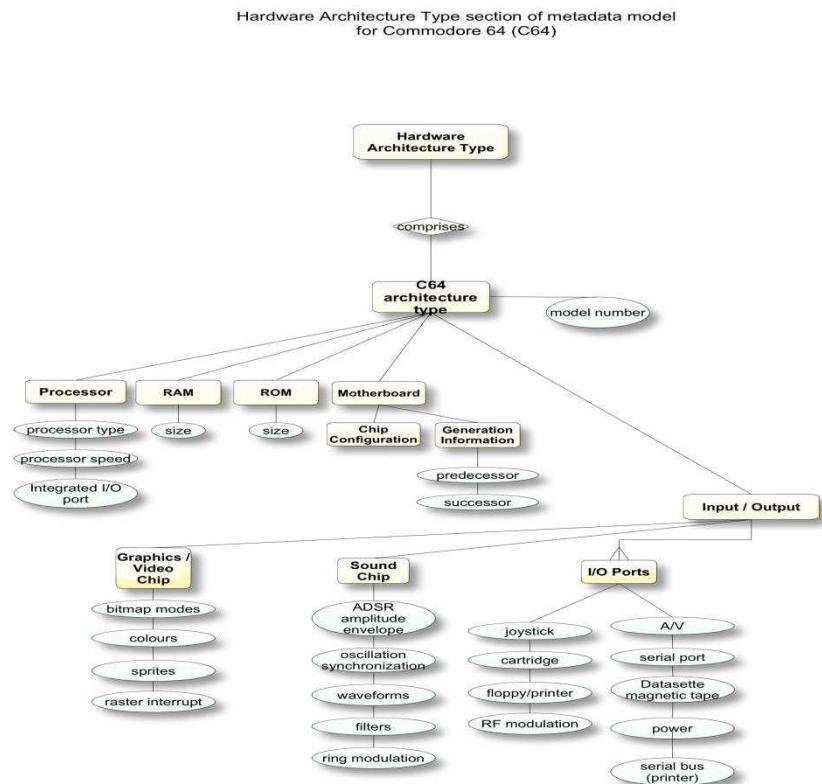


Figure 4 C64 data model

TOTEM

These data models were translated into logical models for use in a relational database. TOTEM, the Trustworthy Online Technical Environment Metadata database, was developed, and to date it is populated with a reasonable quantity of console game data¹. The use of the TOTEM acronym is inspired by the fact that Totem poles are monuments created by First Nations of the Pacific Northwest to represent and commemorate ancestry, histories, people, or events, and would be erected to be visible within a community. The TOTEM registry is used, analogously, to record the complex hardware and software relationships that apply to digital objects, and to make them visible to the digital preservation community. The aim of TOTEM is for a user to enter a version of one of: file format, software, software library, operating system or hardware, and then searching to find compatible information down the stack. For example, entering the PDF file format version would produce a compatible Adobe Acrobat software version on which to run that particular PDF version. Similarly for an operating system version and a hardware version etc. For the file formats, TOTEM contains PRONOM unique identifiers to ensure semantic interoperability. Johanna Puhl from the University of Cologne also created a linked data (RDF) version based on the data model (for details on all the above see the TOTEM book (Delve & Anderson, 2012)).

The de facto library metadata standard PREMIS² has recently set up an Environments working group to look at the need for a separate PREMIS Environment entity, and

¹ <http://www.keep-totem.co.uk/>

² <http://www.loc.gov/standards/premis/>

TOTEM was represented on this group, helping to ensure that the TOTEM registry work is adopted as part of this mainstream registry initiative. The TOTEM metadata schema, also part of the TOTEM book, also contributes towards this, and contains XML mock-ups to aid those in memory institutions responsible for preserving games.

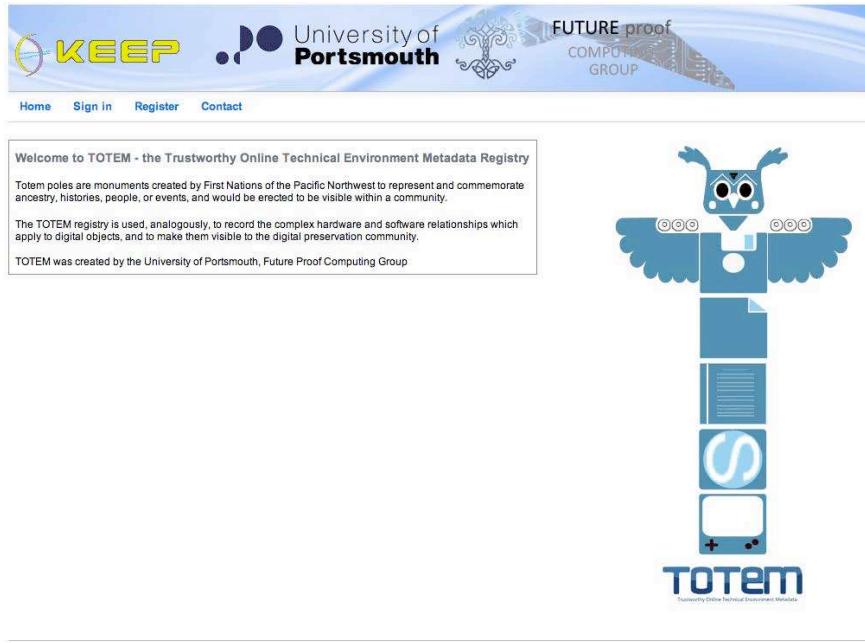


Figure 5 The TOTEM home page.

Figure 6 Console simple search

The screenshot shows the TOTEM software search results for "Super Mario Bros. 3". At the top, there are navigation links for Home, PC Architecture, C64 Architecture, Console Architecture, and Sign out. The main content area displays three entries for SMB3:

- Version Name:** SMB3 European Version
Description: Super Mario Bros. 3, also referred to as Super Mario 3 and SMB3, is a platform video game developed and published by Nintendo for the Nintendo Entertainment System (NES), and is the third game in the Super Mario series.
Release Date: 1991-08-21
Source: http://en.wikipedia.org/wiki/Super_Mario_Bros._3
- Version Name:** SMB3 Japanese Version
Description: The original Japanese version of this game featured several differences from the version of the game that would later be released in North America and Europe. In the Japanese game, Mario always reverts back to small Mario when he is hit, but in the American version he'll change to Super Mario if he is hit while he has a power-up. Peach's joke at the end of the American/PAL version was added in (the original Japanese text simply said, "Thank you! Finally, peace returns to the Mushroom World. The end!") The Japanese version of the game featured different levels names than (most) versions of the American/PAL game (Desert Hill became Desert Land, Ocean Side became Water Land, Big Island became Giant Land, The Sky became Sky Land, Iced Land because Ice Land, Pipe Maze became Pipe Land, and Castle of Kuppa became Dark Land). There were other small changes made as well to specific levels (the end of the Grass Land fortress was slightly altered, as was a level in World 5)
Release Date: 1988-10-23
Source: http://en.wikipedia.org/wiki/Super_Mario_Bros._3
- Version Name:** SMB3 North American Version
Description: The original Japanese version of this game featured several differences from the version of the game that would later be released in North America and Europe. In the Japanese game, Mario always reverts back to small Mario when he is hit, but in the American version he'll change to Super Mario if he is hit while he has a power-up. Peach's joke at the end of the American/PAL version was added in (the original Japanese text simply said, "Thank you! Finally, peace returns to the Mushroom World. The end!") The Japanese version of the game featured different levels names than (most) versions of the American/PAL game (Desert Hill became Desert Land, Ocean Side became Water Land, Big Island became Giant Land, The Sky became Sky Land, Iced Land because Ice Land, Pipe Maze became Pipe Land, and Castle of Kuppa became Dark Land). There were other small changes made as well to specific levels (the end of the Grass Land fortress was slightly altered, as was a level in World 5)
Release Date: 1990-12-02
Source: http://en.wikipedia.org/wiki/Super_Mario_Bros._3

At the bottom of the page, there is a copyright notice: University of Portsmouth, Future Proof Computing Group (c) 2008 - 2012, and the TOTEM logo.

Figure 7: Console Architecture Software Search

The screenshot shows the C64 Compatibility Search interface. At the top, there are navigation links for Home, PC Architecture, C64 Architecture, Console Architecture, and Sign out. The main content area has a search bar labeled "Compatibility Search" and dropdown menus for "Software", "Libraries", "Operating Systems", and "Hardware Types". Below the search bar, there is a form to enter "Filetype Name:" and "Filetype Version Name:", followed by a search icon. To the right, there is a "Need help? Read on:" section with instructions for using the compatibility search, examples, and a list of steps to find compatible software.

Need help? Read on:

Software Compatibility Search allows you to see a list of Software types that are compatible with a specified Filetype and its version.

Example:

You want to know what software is required to render a Commodore Executable Program .PRG file

- type **Commodore Executable Program in BASIC (PRG)** in the field named **Filetype Name**
- type **PRG** in the field named **Filetype Version Name**
- Click on the Search icon or hit Enter

Figure 8: C64 Compatibility Search

But TOTEM is not the only tool developed in KEEP to directly advance games preservation: the KEEP Emulation Framework¹ provides a dedicated platform for various users (gamers, librarians, independent researchers etc.) to render a plethora of different games via multiple emulation environments, the framework carrying out the analysis and selection necessary to determine which environment will suit which game. This framework has been installed at the Computer games Museum, Berlin, for visitors to use.

The KEEP Emulation Framework

Using emulation for delivering various virtual environments in institutions today comes with a high amount of configuration and administration before anything is available for the user. To provide a variety of user-friendly emulators for different digital objects the relevant metadata has to be stored in the digital archive and the different emulators have to be implemented and maintained. A process of automatisation for the recognition and the verification of the data and the allocation of the appropriate emulation environment will inevitably facilitate the process of issuing them to the end-user while eliminating a number of intermediate administrative procedures.

The KEEP Emulation Framework has the resources to perform exactly this very process of automatisation. Via a defined interface, a request for information will be addressed to the digital archive and will activate the EF. The data-file (a single file or the image of a data-carrier) is identified via file-format registries and the appropriate emulation paths will be offered to the user. Selecting a specific pathway will start the emulator and the software package necessary for performing this task.

The EF software consists of three parts: a Core Application, a Software Archive and an Emulator Archive. The Core EF is the technical heart of the system, performing the automatic characterization of file formats, selecting the required software and automatically configuring the emulation environment. It is delivered with a simple GUI to interact directly with the user. For selecting the software and emulator, the Core interacts with external services such as technical registries, e.g. TOTEM or PRONOM, containing file format classifications etc., the Software Archive that contains software captured in predefined disk images and the Emulator Archive that contains the emulators available for the EF.

The Emulation Framework software

The KEEP Emulation Framework is available on the SourceForge portal as a free download. The program and the GUI are written in Java, because it is executable on various computer systems; for the internal database H2 was chosen because of the small footprint and integrated web-interface. An installation program simplifies the installation process.

These are the system requirements:

Processor	X86 32/64 bit 1.5 GHz or faster
Memory	At least 2 GB of memory
Disk space	200 Megabytes if free available space for the base install Depending on the number of emulators and software images, from 1 GB upwards
Operating system	Linux or Windows with compatible JRE and network support

¹ <http://emuframework.sourceforge.net/>

Java Runtime Environment (JRE) Oracle(Sun JRE version 1.6 or higher / compatible

The download package contains the following emulators:

- Qemu (x86)
- Dioscuri (x86)
- WinUAE /Amiga)
- VICE (C64)
- JavaCPC (Amstrad/Schneider)
- BeebEm (BBCmicro)

It must be emphasized that this package may only contain open source software. Thus it will neither be possible to find an operating system such as MS Windows nor an application like WordPerfect to come along with the bundle. It is beyond of the scope of the KEEP project to manage the software licences.

The Emulation Framework User Interface

First we will take a look at the functionalities for the end-user. The EF starts with a graphical user interface. This is an experimental graphical user interface to give a first impression of the functionality. At the end of the project there will be a more effective interface, especially for the administration. With the actual Java-based GUI (figure 9) the user can select a digital object in the left column.

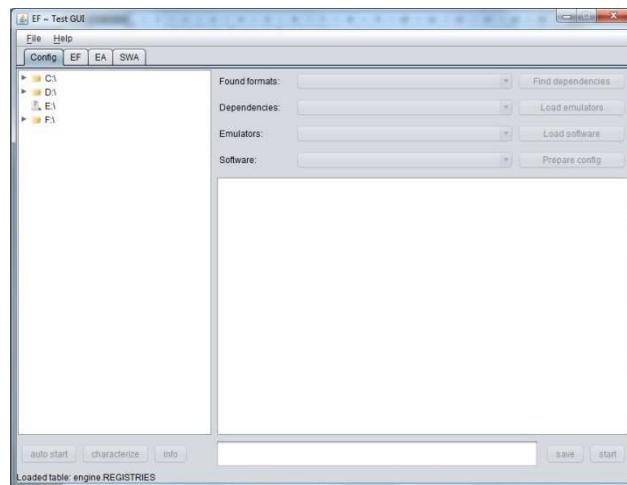


Figure: 9. Java-based EF GUI

To describe the next steps in the procedure, figure 10, a d64-image of a game designed for the Commodore 64 (Ms Pacman) is selected. Having selected the object by clicking on the icon, the lower region of the screen presents three different buttons (auto start, characterize and info). If you click on the button for auto start, a window will pop up presenting the VICE-emulator and the game.

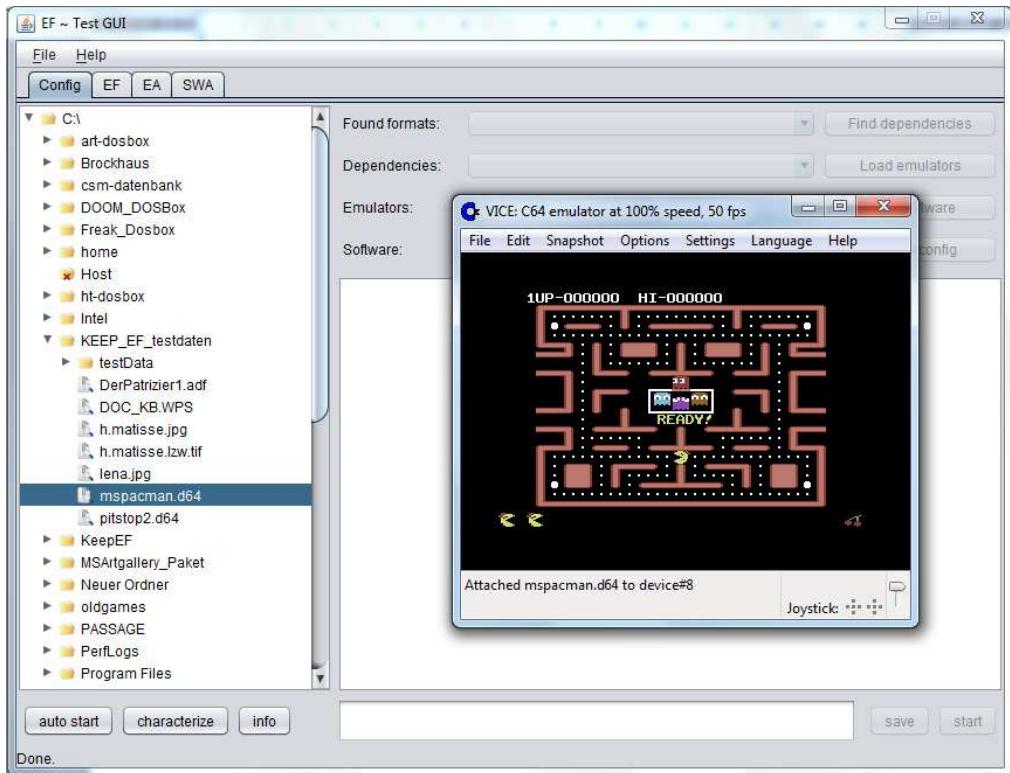


Figure: 10. Commodore64 Emulator VICE with Ms Packman running

So the user is able to start the emulation from the digital archive only by clicking on a button. But in addition to this automatic procedure the user can select between several emulation pathways (if they are defined by the administrator). To illustrate this approach we will select a JPEG file: If the button “characterize” is activated, information in the right upper corner states that JHove has successfully identified the data format to be JPEG.

The next step, figure 11, shows the current dependencies, i.e. which emulation paths have been allocated to this data format by the administrator. In this case the following two are available:

- the program Blocek under FreeDOS on a x86 system
- the program XzgV under Damned small Linux on a x86 system

Now the user can select one of the paths and henceforth the emulators available, in this case the choice is between Dioscuri and Qemu. The next step consists in opting for the appropriate software package. FreeDOS is seen here as being offered in connection with the Blocek-application.

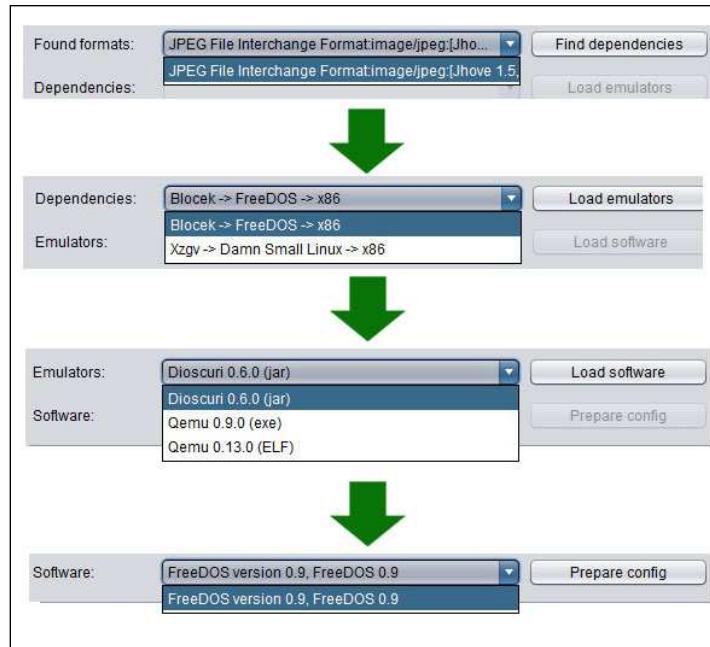


Figure:11 . Characterization

Finally the configuration is being prepared, figure 12. This entails mounting the file as a disk (drive A). The system mounts every object with less than 1.2 MB as a disk, any file larger than that will be tied in automatically as a hard disk.



Figure:12 . Configuration

Once on the level of the emulation environment, this integration is necessary in order to have access to the object. By clicking on the button start the process of emulation will commence. Different to the computer game example, it is necessary to start the program Blocek in the DOS emulation window and the file has to be selected manually. As a result the file will be rendered, figure 13.

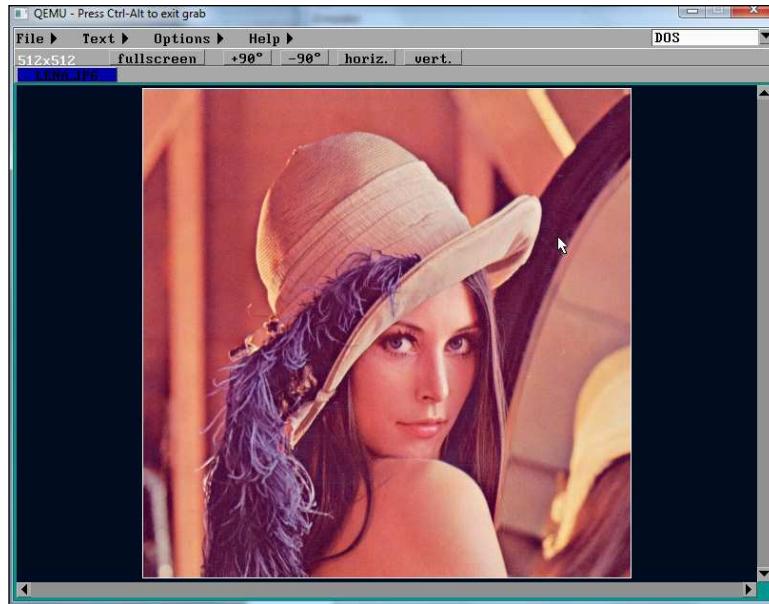


Figure: 13. JPEG-image rendered with Blocek

The Emulation Framework Administration

The concept of the EF is based upon employing three different archives that may operate on different servers. The EF-Core-Archive needs to be installed on the very computer requested to present the emulation. But the archives for both the emulators themselves and the appropriate software have only to be connected with it via LAN or WLAN. This facilitates a central administration of emulators and software for a number of computers or even for an institutional network. In addition to the two format registries contained in the download package it will be possible to create customized registries as well as emulators or software packages and to integrate them in the EF. Thus individual solutions can be created to fit the requirements of a particular organization.

To conclude, the EF will simplify the appropriation of emulators for the usage of original digital objects substantially. Only by identifying the file format a range of appropriate emulation paths could be provided. Furthermore the considerable range of configurations means that customized solutions for emulators, software and individual format registries can be integrated into a framework allowing a high level of automation.

Software Preservation and Computer History Museums

So far the challenges and complexities involved in preserving video games have been reviewed, and it has been demonstrated how TOTEM and the KEEP EF have made inroads into addressing these serious issues in a way that is accessible to mainstream memory institutions. In facing up to such a vast challenge, the DP field is becoming aware of other domains from which it can draw support. More recently, DP professionals have recognised the necessity of preserving software, as witnessed by the dedicated JISC

“Software Preservation” meeting on 7th February 2011¹. On the basis of these talks, Neil Chue Hong of the Software Sustainability Institute, and Brian Matthews, of the Science and Technology Facilities Council were invited to participate in the POCOS events, and their excellent and comprehensive chapters, drawn from the JISC event appear in the first POCOS e-book on Visualisations and Simulations. The discussion of the KEEF above also highlights the need for software archiving.

But we need to go beyond software archiving and accept that we also require to know as much as possible about the hardware platforms used for running computer games. In this we are fortunate, because, like the gaming community, it is mainly volunteers and amateurs that have kept old computers together in museums with all the attendant material: peripherals, documentation, and also software. From these communities some formal bodies have sprung, and there are now a number of associations with whom collaboration is possible on a number of fronts: providing data to inform say TOTEM or the KEEF; and also direct knowledge transfer between computer history museums and memory institutions on say, media transfer etc. Many computer history societies have also created emulators for many past machines, large and small, which can benefit emulation research and practice.

For example, The National Museum of Computing, at Bletchley Park

<http://www.tnmoc.org/about-us> contains old machines in working order, for example BBC micros running old computer games <http://www.tnmoc.org/explore/pc-gallery> figure 13. This museum does not receive any government support.



Hands-on in the PC gallery

Figure 14 PC Gallery at the National Museum of Computing



Figure 15 Screenshot of the The National Museum of Computing website

¹ <http://softwarepreservation.jiscinvolve.org/wp/2011/02/18/7-feb-outputs-key-points-from-the-participants/>

The Computer Conservation Society, on the other hand, is part of the British Computer Society, and is covered by Royal Charter status.
<http://www.computerconservationsociety.org/about.htm>

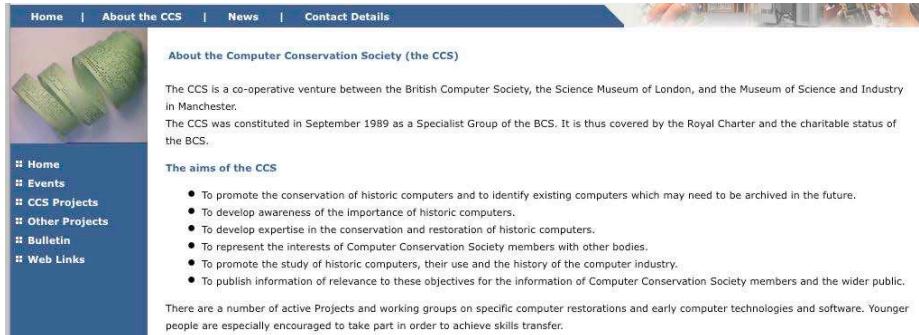


Figure:16 Screenshot of the Computer Conservation Society website

And from the other side of the pond, The Computer History Museum in Silicon Valley, California, with a vast amount of material and expertise: <http://www.computerhistory.org/>



Figure:17 Screenshot of the Computer History Museum website

And last but not least, the IT History Society, a worldwide association for those interested in computing history: <http://www.ithistory.org/> has a database of hardware, and is developing two more databases: software and IT companies. These are of huge value to the DP community and can also be used to inform TOTEM. Some of this discussion has been written up by Anderson (2012) for the computer science / computer history communities, and more is forthcoming in that vein.

Conclusions

There are now a number of mature initiatives to move forward the work on preserving games environments and related metadata. These need to be harmonized and to achieve this all interested parties must continue to build bridges across the disparate communities;

share resources and expertise, and together work with bodies such as PEGI so that systems requirement data can be transferred directly into a suitable technical registry such as TOTEM at the point of publication / age rating and thus provide workable pipelines for harvesting the metadata we currently need.

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Archaeology versus Anthropology: What can Truly be Preserved?

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Abstract. A virtual world is a place. As such, it is made of two components: its environment and its inhabitants. Preserving its environment is possible: environments are embodied in software, which does not decay. Preserving its inhabitants is impossible: they cannot be boxed up, only described. Software preservation gives future generations the archaeology of a virtual world, but they will also need its anthropology if they are ever fully to understand it as a place. Unfortunately, anthropology is not something that can be constructed after the fact: it needs to be on-going right now.

Introduction

This chapter concerns what it means to “preserve” a virtual world.

Virtual worlds are shared online environments exemplified by *World of Warcraft* (Pardo *et al*, 2004), which is a game world, and *Second Life* (Rosedale *et al*, 2003), which is a social world. All virtual worlds bring together a particular collection of six features to create a radically different experience for the player than would be the case if any single one of these features were omitted. The features are (Bartle, 2003):

- An automated rule set (the *physics*) enables players to effect changes to the virtual world.
- Players represent individuals “in” the virtual world through which they act (their *character* or *avatar*).
- Interaction with the world takes place in real time.
- The world is shared, so other players can be encountered in it and the changes made by any one player affect all players.
- The world is relatively persistent: if you stop playing, the world continues.
- It is not the real world (*Reality*).

Most virtual worlds are game worlds, and as such are often referred to as Massively Multiplayer Online Role-Playing Games (MMORPGs, or MMOs for short). Although what I discuss here applies to all virtual worlds, players of game worlds so outnumber players of social worlds that virtual worlds as a genre are usually sold as a form of computer game. This suggests that if we were to preserve them, the techniques used to preserve other types of computer game can readily be applied.

As we shall see, however, virtual worlds differ from computer games in some important ways that impact on their preservational demands.

Preservation

There is much to virtual worlds. Before delving into what we should preserve of them and how we should preserve it, we should first consider why we would want to preserve anything at all.

The initial response to the non-expert's question "Why do we want to preserve X?" is "So that future generations can learn from X". Learn *what*, though? There are three basic responses as to what the people of the future can learn from what we present to them through preservation:

- They can learn about us.
- They can learn about themselves.
- They can learn why important things are important.

Put another way: history, literature and art.

1. History

Historians aim to understand the old meanings of old artefacts – what the past meant to the people of the past.

Preservation is important to historians because it gives them a source. From multiple sources, they can reconstruct the past. They can then explain the past in ways relevant to their present. These explanations in turn act as historical documents for the generations of historians that follow. For computer games, the primary artefacts that require preservation are the games themselves.

Suppose a game historian today is playing the decades-old arcade game, *Galaxian* (Sawano *et al*, 1979). The historian can only imagine what it must have been like to play the game when it first came out¹, but this *is* actually possible: the historian puts aside their present-day self and tries to play as their "period" self, based on their accumulated knowledge of what the games landscape was like back in 1979. This can help the historian understand what games meant to people back in the day. Strictly speaking, game historians don't *have* to play the games they study, any more than the historians of Ancient Rome have to participate in gladiatorial combat; however, if we preserve the games for them anyway, at least they have the option of trying them out or not.

To preserve a game for use by the historians of the future, the task is similar to that faced by a library in possession of a collection of ancient texts. The physical source is maintained whenever possible, but its content is made available in a more accessible and less fragile form. For example, if a historian today wants to read the Magna Carta, typically they will have no need to touch the actual document – a transcript or a scan will suffice. An examination of the original copy would only be necessitated if the medium itself was the subject of the research, rather than the message (to compare the quality of its vellum to that of other documents of the era, say).

So it is with computer games. The original hardware should be preserved in working order if at all possible for the benefit of researchers for whom the hardware is itself their chief focus. Unfortunately, repeated use of aging hardware will inevitably degrade it. Researchers who are primarily interested in the content have no need to use creaking old pieces of electronics, so ought therefore to be provided with a simulation (of the hardware, running the original software) or a facsimile (in which the hardware and software are both non-original, but the content they implement is by and large

¹ It was like playing *Space Invaders* (Nishikado *et al*, 1978), except I could get to the second screen...

indistinguishable from the original content). The advantage of digital preservation this way is that if the original form perishes, the copies can live on; this is why we can still read Homer's *Odyssey* today even though the last remaining original copies decayed thousands of years ago¹.

2. Literature

Students of literature begin with the fact that a text does not mean today what it meant in the past. They are concerned almost entirely with examination of the content of preserved artefacts, as opposed to the form. When they do look at what an author “meant” by what was written, it is only as one of many techniques for finding new ways of interpreting the content; the “real” meaning of the content to the author and the readers of the past is not directly relevant.

The central thrust of this approach is that texts are situated in their historical context but their content is open to new interpretation. Language and symbols change meaning over time. More importantly, *readers* change over time. Jane Austen 2012 is not Jane Austen 1816. The same applies whether the artefact is literature, music, dance – or computer games.

A Games Studies expert looking at an old computer game isn't trying to extract old meaning from old symbols: they're trying to extract new symbols from it, to which they attribute new meaning. The designer of the game ceded authorial control over their work the moment it was published: it became an artefact, for people in general to interpret how they will. How many children who play *Snakes & Ladders* either know or care that it's a centuries-old Indian game created to convey the notion of fate? They play it simply because (for them) it's fun.

If someone plays a 1985 computer game for fun, does it matter whether it's 1985-player fun? Isn't the fact that it's today-fun more important to that player?

Preservation of games for the benefit of future players is, in this scenario, a case of presenting them with an artefact that was useful in the past in the hope that they can find some use for it in the future. It presents itself as a flawed mirror: the past is like the present, but different in small ways. In interpreting its imperfect reflections, the users of the future notice differences compared to the contemporary reflections they are used to seeing; in reconciling these, they learn more about who they are and about the society in which they live.

In practical terms, this means that content is more important to preserve than form. Physical hardware is only important as an object of fetish, in that its existence as a connection to the past might inspire certain players to take an interest in the historical aspects of the work. However, it should be remembered that for multi-player games, “content” doesn't simply mean the embodiment of rules in software: other players are content, too.

3. Art

The Mona Lisa² can be looked upon as a document of life in 16th Century Tuscany – that is, from an historical perspective. It can also be seen as an enigmatic image of a beautiful

¹ If indeed the “original” oral tale was ever written down anyway.

² Or La Gioconda

woman, or an admirable work of high craftsmanship – that is, from a literature perspective.

A third way of looking at it is as an expression of artistic intent. In this perspective, the artist is attempting to convey a message through (in the *Mona Lisa*'s case) his work. By experiencing the work, an individual can pick up what the artist was trying to say.

Whether a game is old or new, its players can't help but gain some insight into the mind of its designer as they play. The more they play, the more they see how ideas develop and change over time, and pick up signature design tropes; they can tell a Molyneux game from a Meiers game as easily as they can tell a Mozart piece from a Lady Gaga piece. In gaining this understanding, such players are better able to create their own games, should they have something they want to say that they can't express better some other way.

Preserving games is important because it allows the designers and critics of the future to understand how things got to be how they are, so they can better understand the trajectory of where they are going. Only by understanding the rules can you wilfully break them; only by understanding what has been said can you disagree; only by reading can you learn to write.

For a game critic or a game designer of the future, games from the past should be preserved because they are saying something important that can't be separated from what they are. As to what those important things *are*, well you'd have to play the games to find out: that's the point.

Virtual Worlds

All this would be fine if virtual worlds were games, but they're not. Even game worlds aren't games: they're places. Just like places in real life, the people who live there are part of the place. You can't talk about Leicester without considering the inhabitants of Leicester; you can't talk about *Star Wars: the Old Republic* (Ohlen *et al*) without considering the players of *Star Wars: the Old Republic*.

What virtual worlds *are* is bound up with who inhabits them. You can't separate the two without missing half the picture. The players of a virtual world are an intrinsic part of the historical context, the artefact created and the medium through which any authorial message is being delivered. Without them, you have an environment but no virtual world.

Preserving only the software of a virtual world is like preserving only the buildings of a city. That's better than nothing, but it basically leads only to future archaeology. The space is saved, but the space is only part of what a city is. Historians have to reconstruct what the people who lived there might have been like; students of literature can repurpose the ruins but not the culture; artists can see the empty streets but only imagine what the players who travelled them meant.

If we are preserving virtual worlds for a purpose, we should strive to help people make use of what we preserve for that purpose. For virtual worlds, this means preserving the players as well as the software and hardware that constitute the world.

Of course, cryogenically preserving a representative sample of players is neither morally nor technically feasible. Given that we can't preserve actual players, the next best thing is to preserve studies of them. As it happens, there is a discipline for studying cultures, communities and the social relations between people: Anthropology. Unfortunately, anthropological studies can only be undertaken while a virtual world is alive and vibrant; as in real life, it's no use writing an ethnographic study of Pompeii *after*

it has been buried in ash – it has to be done beforehand if it is to capture the essence of the place.

Expense aside, there are practical problems with creating on-going studies of virtual worlds:

- The worlds themselves can change. *World of Warcraft* today is not the same as the *World of Warcraft* that launched in 2004¹, as a result of which the hardcore-to-casual ratio of players has dramatically fallen.
- Individual players themselves mellow over time and behave differently.
- There can be cultural differences between servers. Some of these may reflect real-life cultural differences², but some don't³.
- Studies tend to last months, but perhaps ought to last years.

That said, anthropological studies of virtual worlds do exist. To get a sense of what *Second Life* was like in its heyday, look no further than Boellstorff (2008). Perhaps more poignantly, Rosenberg's (1992) ethnography of *WolfMOO* is all that remains of a once energetic and effervescent virtual world. Such works of scholarship are few and far between, however, in part as a result of the time and effort it takes to collect the data and in part due to a (not entirely unfounded) suspicion among senior anthropologists that the people who want to study virtual worlds are merely using that as an excuse to play them more. It would help if major virtual world development companies had anthropologists on their payroll, but unfortunately trained fieldworkers are not at the forefront of many hiring strategies right now.

Nevertheless, we could do more in other ways to help the people for whom we are preserving virtual worlds. Examples include:

- Video recordings of people (actually players, not academics) playing at various stages in their playing career.
- Interviews with players, designers and developers.
- Design documents.

We should archive what we think the people 200 years from now will need to know in order to make sense or use of what we're preserving. We should also leave notes telling them *why* we think they'll need what we're preserving for them (and perhaps apologising for obvious omissions...).

Conclusion

If something is worth saving, it's worth saving for a reason. We should anticipate that reason and provide as much supporting material as we can to aid the researchers of the future.

For virtual worlds, *of course* this would mean the hardware and the software – that goes without saying. However, it would ideally *also* include anthropological studies. Virtual worlds are designed to be inhabited, and the inhabitants are *part of the design*. To overlook them is to overlook what virtual worlds *are*.

Indeed, the same applies to some extent to all computer games. They are more than just the hardware and the software: they are also the players. Designers of games don't merely

¹ Especially following the *Cataclysm* expansion that rewrote the map.

² Players from the Far East can play the same game very differently to players in the West.

³ For example, there may be two routes through a large room. On one server, players take the right route; on another, they take the left route.

design for the direct behaviour of players, they design for the emergent behaviour of players; because games are interactive, players are akin to necessary components that have to be designed for. To preserve what a game *is*, in any sense, the players must be included.

The hardware and software is nonetheless probably the best place to start preservation, though...

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Preserving Games for Museum Collections and Public Display: The National Videogame Archive

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Abstract.

The National Videogames Archive (NVA), founded in 2008 at the National Media Museum, in partnership with Nottingham Trent University and Bath Spa University, aims to preserve videogames for the future. The archive includes hardware, software, unique prototypes, concept art, original design sketches, magazines and related ephemera. All the items have their own specific needs for successful preservation, both physical and digital. Public access is also a priority for the NVA and solutions have been found for sustainable display methods. This paper and presentation will reflect on these proven solutions and provide plans for overcoming the challenges surrounding videogame preservation and display in the future. Introduction to the National Videogame Archive

Introduction to the National Videogame Archive

Formed in 2008 as a partnership between the National Media Museum in Bradford, West Yorkshire and Nottingham Trent University and drawing on expertise from colleagues at Bath Spa University, the National Videogame Archive aims to collect, interpret, make accessible for study and research and, where possible, exhibit videogames and the associated ephemera of videogame cultures.

Formerly known as the National Museum of Photography, Film and Television, the National Media Museum changed its name in 2006 to encompass wider forms of media and reflect the radical impact of digital technology. As a key part of this refocusing, in 2007 the Museum created a new Curator of New Media role to widen the collection within the areas of internet and computing technology, videogames and digital art. At the same time, researchers at Nottingham Trent University and Bath Spa University were conducting feasibility research to investigate the efficacy of formal preservation and exhibition strategies and environments for UK videogames. Following consultation, The National Videogame Archive - a sub-division of the Museum's National New Media Collection - was launched in October 2008. (See National Media Museum Collecting Policy Statement, 2010)

The NVA aims to preserve, analyse and display the products of the global videogame industry by placing the games in their historical, social, political and cultural contexts. This means treating videogames as more than digital code that can be dissected and emulated or as a system of rules or representations. At the heart of the NVA is a respect for the material form of the game as well as the boxart, manuals, advertising, marketing and merchandising materials that support it and that give it meaning and context.

In addition to collecting, curating and archiving these vital parts of popular culture, the ongoing research of the NVA is oriented around exploring and devising innovative and engaging ways to exhibit and analyse videogames for a general audience. This involves considering the interpretation and display of videogame experiences for diverse audiences

that might include adepts and non-adepts alike, and exhibition in environments such as museum galleries which are not normally conducive to videogame play (e.g. Newman 2012, 2011, 2009; Newman and Woolley 2009).

Types of material within the NVA

The NVA is the Museum's youngest collection. It includes more than 2000 individual items ranging from software and hardware through to fan-made maps, developer documentation, prototype hardware interfaces and controllers, and assorted ephemera including magazines and other computing and gaming publications. At present, the majority of the items in the collection have been donated by the British public but the collection also includes objects gifted by members of the international games industry (including prototype Rock Band controllers donated by Harmonix, the first prototype EyeToy PlayStation USB camera donated by Sony London Studios, and development sketches and designs for Samarost donated by the game's developer, Jakub Dvorsky) In addition, in 2011, the NVA acquired a large number of objects from the British Film Institute who had amassed a collection of gaming hardware, software and ephemera during the 1990s.



Figure 1: Rock Band guitar and drum kit prototype controllers donated by Harmonix.

Importantly, unlike many amateur collecting projects such as the High Voltage SID Collection (HVSC), for example, the NVA does not and cannot aim to be a completist collection. As such, decisions are informed by the collecting policy which identifies key areas and narratives around which directed collecting takes place.

As its mission statement and collecting policy indicate, the NVA's aims are wide-reaching. Centring on the moments of creation and development, the texts themselves, through the reception of games by fans, journalists and critics, the collection seeks to document the complete lifecycle of videogames.

In order to put this vision into practice, the NVA aims to collect around the following areas:

Hardware

The NVA has a comprehensive collection of gaming consoles, computers and peripherals that have shaped the way we consume and play videogames. From the Magnavox Odyssey, the world's first home games console released in 1972, to the latest hardware releases, the NVA aims to preserve devices that have influenced the way the public have experienced games in the best condition possible. As well as mass produced consumer services, the NVA also includes several unique prototypes that have been donated by members of the international game development and journalism communities.

Software

The majority of the NVA's collection comprises games software. Currently, software programs are stored on their original, portable media and include compact cassettes, floppy disks, CDs and DVDs as well as other proprietary formats including various cartridge and disc-based systems. The NVA aims to collect landmark titles that have captured the UK public's attention and demonstrated innovation that has pushed the medium of games forward. The NVA currently holds a large collection of Sinclair Spectrum, BBC Micro and Commodore 64 cassette tapes from the 1980s.

Marketing Materials

Alongside the games and consoles, the NVA is also building a collection of games industry marketing materials that aim to place the medium within a cultural context and preserve how games have been advertised and sold to the public. This section includes posters, magazines, television commercials and websites.

Games Creation and Design

To explore the production of videogames the NVA also includes design documentation – from the earliest ideas scrawled in a notepad through to concept art, character and level design. A key aim of the NVA is to build a collection of games production material that tracks the development cycle of key titles. In addition to collecting already-existent materials, a key strategy for documenting development practice has been the instigation of the 'Director's Commentaries' project. Drawing on the collaboration with colleagues at

NTU and, in particular, the GameCity international videogames festival, the Director Commentaries project mimics the DVD extra format by inviting game developers to critically reflect on their professional practice by narrating playthroughs of their games. Commentaries are presented both as live events and video-recorded pieces and form a key interpretative resource and a means of capturing the development stories of key games, studios and individuals.

Community Materials

The vibrant and passionate fan communities that surround many games aims to be recorded by the NVA to help illustrate and preserve this incredibly rich and valuable resource. This area includes player-generated walkthroughs, fanzines, fan fiction, fan art, speedruns and websites. The collection of fan-generated ephemera is key to the NVA's mission as it is these materials that reveal much of the meaning of videogames to their players. The diversity of fan-produced materials such as superplay videos, walkthroughs and machinima, speak to the malleability of videogames and their ability to be re-made and played with by players. Videos of gameplay, for instance, illustrate the use of specific techniques (including the exploitation of bugs, glitches, and other inconsistencies in the operation of gameplay) that may be central to the use of games within particular communities and contexts.

Challenges of Games Preservation

The challenges surrounding the preservation of videogames are extensive and the NVA is working to provide successful case studies that explore how games can be preserved so they can be experienced by future generations. The Museum's 'Games Lounge' has proved to be a key site for information gathering particularly in relation to questions of objects handling, resilience and durability.

Hardware Preservation

Firstly, the plastics that are used to produce many items of hardware and software within the collection are fragile and easily degradable. In recognition of the severity of material deterioration, the Museum stores all NVA items within an environmentally controlled space with the following specifications:

- 18 – 22 degrees Celsius
- Relative humidity 45% - 55%
- UV under 10 microwatts per lumen
- Visible light – less than 50 lux

(See 'Specifications for new showcases: Ingenious Plastics Centenary 2007, Science Museum'.)

However, there is more to the material care of videogames than the deterioration of plastics. The electrical components of videogames hardware (and software in the case of cartridges) may also prove to be extremely fragile and typically systems require considerable maintenance to keep them running. Many of the items within the NVA collection are working models but are never turned on in an attempt to preserve their original condition. However, while such precautions may preserve the outward

appearance of these objects, not running the machines or plugging/unplugging cartridges may, in certain circumstances accelerate the ageing process as specific electronic components lose charge, corrode and may ultimately become inoperable. Ideally, and in common with other similar collections, the NVA aims to build an accompanying handling collection of objects that are designed to be switched on and used by patrons.

Software Preservation

The National Media Museum, together with the wider Science Museum Group is currently working towards a sustainable solution to preserving digital assets. The fragility of portable magnetic media and the effects of bit-rot are well documented even if their true extent is not yet fully understood or predictable (see Lowood *et al*, 2009) and the NVA is collaborating with other institutions already working within this area to build a secure and reliable digital repository of videogames, whilst retaining the software in its original formats in the best conditions possible. Digital images are currently being preserved within the National Media Museum's image archive and manageable solutions for preserving video and audio assets are being assessed.

In recognition of the importance of the fan cultures that support and sustain games as well as the desire to understand 'gaming' in its widest context, the NVA has developed a partnership with the British Library to build a special collection of websites as part of the UK Web Archiving project. Announced in 2012, the gaming special collection will build a collection of industry and community produced websites that illustrate the impact and influence of videogames on society.

Public Exhibitions

Whilst the various objects in the NVA's collection are available to view and research at the National Media Museum (the Museum operates a system whereby patrons may request access to specific objects from the collection), in order to showcase the NVA and reflect the new digital culture remit of the Museum, the Games Lounge public gallery opened in February 2010. Initially sited in the foyer entrance of the Museum but now relocated to a larger gallery space, the Games Lounge includes a selection of playable original arcade and console games as well as titles playable under emulation, alongside key items of contextualising ephemera.

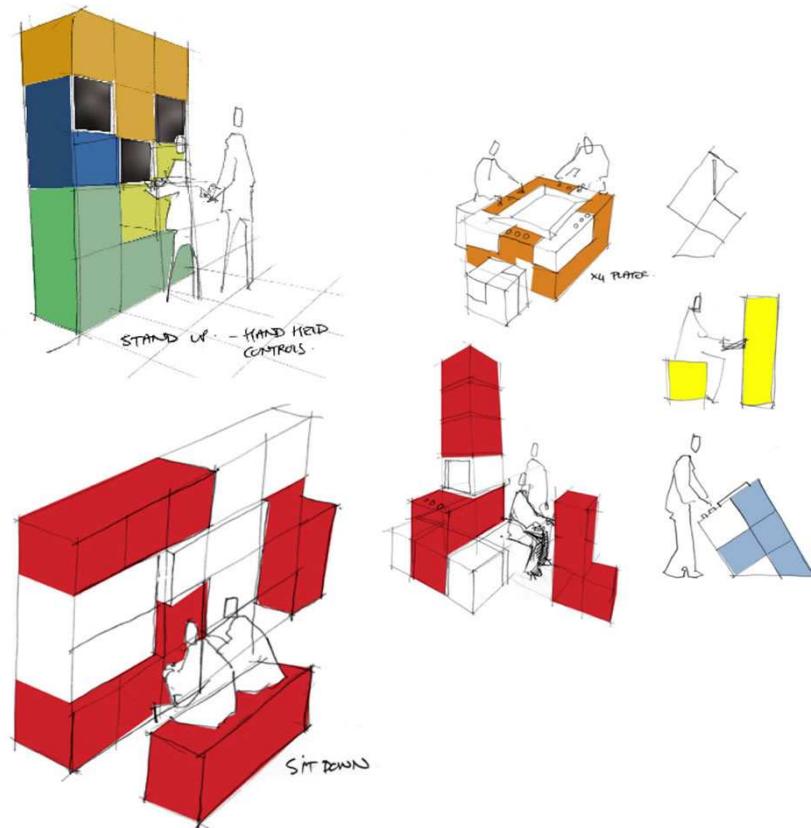


Figure 2: Concept design sketches for the Games Lounge by Roy Crone, NRN Design

Arcade Cabinets:

Space Invaders, Asteroids, Galaxian, Pac-Man, Defender, Centipede, Donkey Kong, Frogger, Gauntlet, Street Fighter II, Point Blank

Emulation:

Manic Miner (ZX Spectrum), Prince of Persia (DOS)

Original console & controllers:

Pong (Atari VCS 2600), Mario Kart (Super Nintendo), Sonic the Hedgehog 2 (Sega Megadrive), GoldenEye 007 (Nintendo 64), Actua Soccer (Playstation 1)

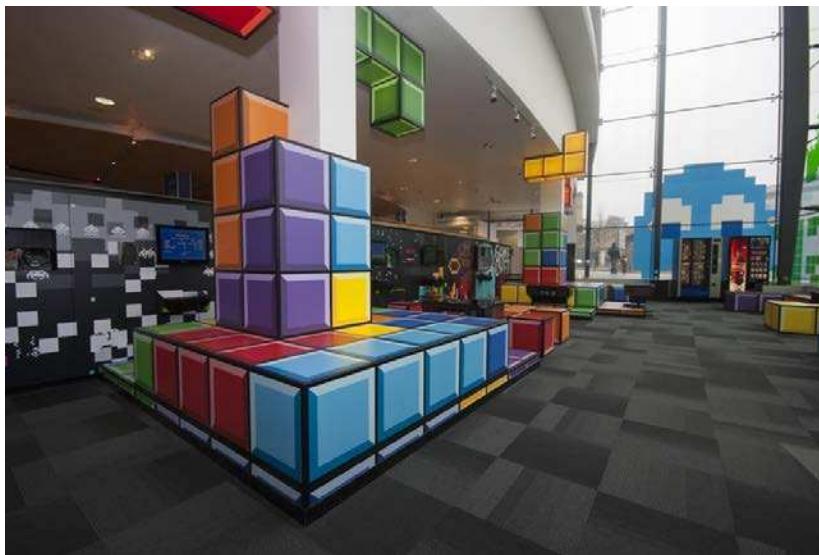


Figure 3: Interior of the Games Lounge at the National Media Museum, 2010

All of the games are heavily used by the public. Confounding initial expectations, the arcade cabinets have proved to be comparatively problematic and require regular maintenance. Given their original intention, location and apparently robust design, the fragility of the arcade cabinets in the collection was unexpected. Numerous problems have been encountered by transporting and moving the original cabinets. This has highlighted loose connections and fragile circuit boards. The CRT monitors contained within the arcade cabinets have also demonstrated signs of age through several cases of image strob ing/flickering and display malfunction through extensive use and overheating. Another regular symptom has also been malfunctions and blockages in the coin operation system created by visitors using the incorrect coins.

Moreover, while modern emulations making use of custom controllers but running emulated code on generic PCs, have proved to be as reliable as anticipated, the robustness of 1980s and 1990s consoles has been similarly high. As such, putatively fragile devices have required only very minimal input from the Museum's gallery maintenance team. The team will continue to monitor and report on the situation.



Figure 4: Museum visitor playing emulated version of Manic Miner through an original ZX Spectrum keyboard.

The use of emulation is obviously somewhat controversial in relation to videogames. First, and most widely discussed, emulation and, in particular, the acquisition and use of commercial ROMs (the generic name for extracted game code), is typically categorised as software piracy as it requires circumventing technical measures of protection such as DRM (digital rights management). Second, given the importance of the ‘feel’ of gameplay, emulation poses problems for those sensitive to the presentation of playable games. As Newman (2011) notes, ‘even the most seemingly minor variations in the operation, look and feel of digital games have considerable impacts on the experience of play.’

Moreover, as McDonough et al. (2010) have noted in the *Preserving Virtual Worlds* final report, there are not only considerable variations between the audio-visual and interface operation of different emulators even when running the same extracted code, there are manifest differences between even the qualitatively ‘best’ emulators and the original hardware/software combinations (assuming a definable original can be identified as is particularly problematic in the case of PC games or even consoles requiring connection to TV displays as the specificities of audio and video output are highly contingent on display technologies, see also Montfort and Bogost 2009).

At this stage in the development of the NVA’s exhibition strategy, the development and assessment of practical solutions to emulation is key. The Games Lounge presents a vital testbed within which to evaluate the efficacy of emulation for specific audiences. We might tentatively suggest that while the specificities of the CRT blurring and scanline interference that Montfort and Bogost note, or the importance of frame-accurate emulation for expert players of Street Fighter IV as Newman notes in relation to play performances such as frame reading, for more general audiences such nuances will be comparatively insignificant if not unnoticeable. This certainly raises important questions about identifying audience(s) and their particular needs for any game archive or collection (see Bogost 2007).

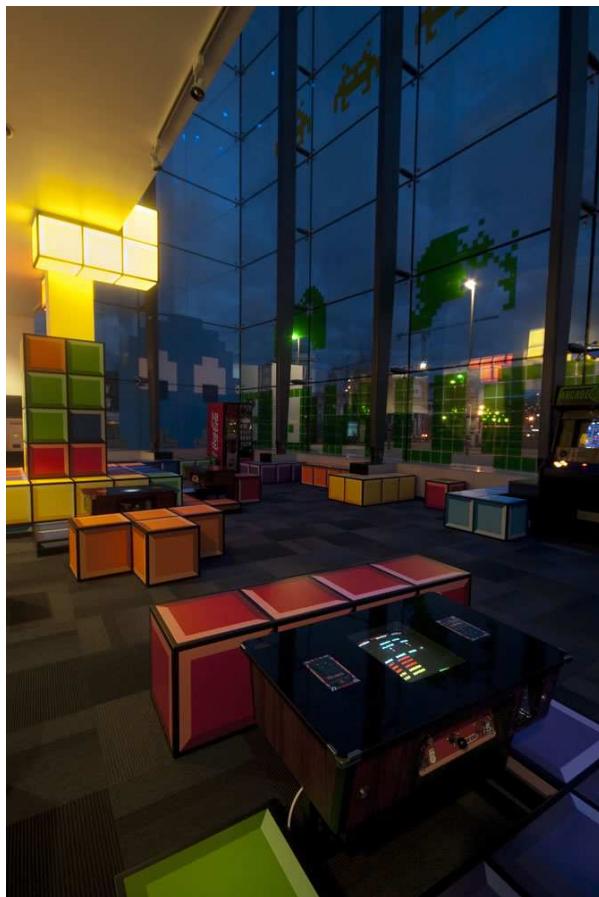


Figure 5: Interior of the Games Lounge at the National Media Museum, 2010

For the Games Lounge, the emulated titles have been developed with the user experience in mind, and patron feedback suggests that the current solution is a successful compromise between an accurate, genuine experience and a robust, maintainable working exhibit. To be a truly authentic experience, the Museum could have used an original ZX Spectrum computer running Manic Miner from cassette tape. This would have to have been loaded everyday before the public arrive and reloaded if the fragile system ever crashed. The emulated solution works from a Windows PC running a ZX Spectrum emulator and simply boots up automatically every morning. The PC keyboard micro controller has been rewired into an original ZX Spectrum keyboard in an attempt to recreate the authentic experience. Just as Bogost has invited us to consider the importance of visual displays, we should perhaps also muse on the potential significance of the anticipation and expectation that is built through the cassette loading process and question whether this forms part of the experience to capture and communicate.

The current selection of titles included in the Games Lounge has been guided by a desire to show the evolution of games across different platforms, hardware and genres. Multiplayer experience and quick bursts of enjoyment were also considered to create a gallery that demonstrates a broad spectrum of games that are easy, fun, intuitive and quick to play. As such, we must recognise the specific context in which the Games Lounge activity takes place and the intersection between the ambitions of curatorial teams, researchers and the strategic, operational and managerial imperatives of a national institution.

Of vital importance, for each game in the Games Lounge, the Museum sought permission from the copyright holder to display the game free of charge within the gallery. The significance of this endeavour should not be underestimated and the sheer amount of time and effort involved in just the process of identifying rightsholders in this most complex field of co-owned and licensed intellectual property may prove to limit the scalability of such an initiative. Strategies for dealing with IP in relation to formal preservation practice continue to present themselves as among the most urgently needed in the sector. In part, this motivates the NVA's partnership in the European Federation of Game Archives, Museums and Preservation Projects (EFGAMP) coalition.

The Games Lounge is soon to be relaunched in a new permanent space within the Museum. This allows the NVA a larger public space to try new and different games and experiment with strategies for displaying and engaging with videogames in a gallery setting. The Games Lounge and other temporary exhibition spaces can also be used as a catalyst to drive the collection forward and acquire new material to help the NVA grow.

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A National Library Perspective On The Preservation Of Games

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Abstract This chapter considers issues relating to the preservation of computer and video games from the viewpoint of a national library. It summarises the current position and difficulties, and proposes a number of potential contributors to achieving improvement in this area. It describes briefly what a successful outcome might look like for both the library and the wider games community, and outlines a number of initiatives being undertaken to move towards this.

Introduction

Despite all the work and initiatives which are currently being undertaken regarding Digital Preservation, there is wide agreement that there is still more to be done. This article will consider how to ‘Make A Difference’ and how to ‘Move Forward’, particularly in the preservation of computer games.

It will address:

- The current position at the British Library (BL)
- What are the big issues to be addressed in digital preservation,
- What success would look like
- What practical steps are being taken at present.

At the BL we have a diverse and growing collection of material. At one end of the range we have born-digital content, for example websites, which have a great deal of complexity within their content. At the other end we have rapidly-growing digitized collections – BL is undertaking large-scale digitisation projects which involve scanning millions of pages of physical material. Overall, we are facing substantial challenges from our own collections.

In addition, the BL plays a leading role in a number of collaborative projects in which we are attempting to increase our ability to undertake digital preservation. Some of these projects focus on research, and some on tools, particularly those which will enable the Library to scale up its operations. The volumes involved preclude manual operations, so it is necessary to automate our processes, and we require tools to enable us to do this.

BL is a member of the Digital Preservation Coalition and also of the Open Planets Foundation. Until recently, however, BL had not been very active in the preservation of video games, but there is now growing interest in this area. BL does have a small and little-known game collection, which we have collected alongside non-digital Legal Deposit material. The legal status of these is uncertain at present, but this collection may present an opportunity to undertake further digital preservation in the future. The collection is mainly composed of cover discs from printed magazines. This means that the collection focuses on a particular era when these discs contained either full or cut-down demonstration versions of computer games. The formats of these ‘discs’ vary and some of

them are in audiotape format - for example for the Sinclair Spectrum dating back to the early 1990s.

Issues to be addressed

When deciding what to preserve, it is first necessary to address the question “Who are the audiences?”. This question is not yet well-answered. The first group proposed is “Researchers”, although this group represents a wide group of interests encompassing:

- Social Scientists, Health and Education Professionals;
- Researchers into a wide range of historical perspectives including the evolution and impact of games on hardware and software;
- Gamers themselves;
- The public.

In short, there is not yet a clear model of the full range of those with an interest in the preservation of games. However, if further investment is to be obtained for games preservation, then a credible Business Case must be built to justify this.

One example of a Business Case, which was created during a workshop session at the 3rd POCOS Symposium in Cardiff, proposed the preservation of games design materials to provide valuable training resources to support future staff for the UK games industry, the development of which will generate additional revenue for UK plc.

When considering what should be preserved, there is an extensive list of potential items:

- Production materials, including source code, 3D models, maps of the game environment, original games designs and storyboards.
- Copies of the original boxed game, advertising material, downloads and upgrades, peripherals and associated hardware.
- Documentation about the users’ post-release experience when playing the game, together with Frequently Asked Questions about the game as well as walkthroughs, video recordings and dumps of enthusiasts’ websites

Several questions arise. How much should be preserved? There are two options – to choose a selection of games and their related content or to create a comprehensive archive of all games. How should preservation of games be achieved? Without doubt, games are amongst the more complex objects to preserve, but preservation is achievable providing funding is available. Certainly the contextual information is easier to preserve than the games themselves. There are however legal issues to be considered. The complexity of these is well-described in a report produced by the KEEP Project¹

Let us now consider the Legal Deposit issues in greater detail. The BL is one of the UK’s Legal Deposit Libraries. In 2003, the Legal Deposit Libraries Act introduced the voluntary deposit of digital materials, although few, if any, games were deposited under this scheme. The Act also introduced a framework to allow for the later introduction of compulsory legal deposit of digital materials, although as at 2012 there is no legislation to provide for this. The BL continues to lobby for this legislation and some progress is anticipated in 2013. Legislation is expected to focus on online content but is not likely to cover deposit of published games. Some other European countries do, however, have

¹www.keep-project.eu/ezpub2/index.php?/eng/content/download/20703/103715/file/D2.6_laymansguidelegalstudies_final.pdf

compulsory legal deposit of digital materials. At the time of writing this article, the consultation period for the Hargreaves Report¹ was still open and so further comment on this was expected.

There are, three separate groups that can engage in games preservation:

The first of these are Memory Institutions. The National Videogame Archive is of course fully committed to this activity, but they require support from other memory institutions that offer the advantages of longevity as well as expertise in the preservation of particular types of material. The question is whether they have an appropriate mandate to preserve games. Libraries and archives have expertise in relation to the preservation of data and content. Museums are able to preserve hardware. There is, however, no organization in the UK with a mandate to preserve the software itself, and without this functional software, preservation of the other components achieves little².

The second group are the games enthusiasts themselves. To date, it is these enthusiasts who must take much of the credit for the successful preservation of games. Enthusiasts, however, whether groups or individuals, cannot assure longevity either for the storage of games or a commitment to support them. In addition, enthusiasts are sometimes on questionable legal territory when they transfer and store a third party's IPR.

The final group are the Publishers and Developers, and engagement with group seems absolutely critical to the successful long-term preservation of games. In practice, however, to date, support from publishers and developers varies.

In a recent exercise, the enthusiasts' website for the Sinclair Spectrum, "World of Spectrum"³, set out to create a downloadable archive of Spectrum games. When they sought permission from publishers and developers to publish their games, most of the smaller organizations and individuals gave permission to do so. Larger publishers were less willing for this to happen however. This suggests that they still consider that these games have commercial value that they do not want to lose. In such cases, the question arises whether memory institutions can provide a 'compromise space' in which they can perform digital preservation without impacting on the commercial value of the game. This opportunity requires further exploration.

The future

One needs to visualise a model of true success in achieving games preservation. This would most likely to occur in a 21st Century digital collection that crosses traditional collection boundaries and contains and links together a wide range of items from software to newspapers, website, books, photographs and video into an integrated whole, thereby enabling every aspect of a game to be explored from a single point while maintaining links to associated material (e.g. other games by the same author).

The British Library intends to create a Web Archive Special Collection covering videogames and games culture which will leverage the Library's existing web-archiving infrastructure. A Web Policy Group will be established including representatives from the National Videogame Archive. This group will define the collection policy for websites which might contain actual games, or other supporting material such as walkthroughs or games experience. Websites can also be nominated by the public.

¹ <http://www.publications.parliament.uk/pa/cm201213/cmselect/cmbis/367/36702.htm>

² However, see the chapter by Neil Chue Hong of the Software Sustainability Institute in POCOS e-book 1, Preserving Visualisations and Simulations and Janet Delve's chapter in this volume that covers the role of computer history museums in digital preservation.

³ www.worldofspectrum.org

BL are also sponsoring a study to be undertaken by the Digital Preservation Coalition (DPC) and guided by the National Videogame Archive to identify audience needs and to propose how to proceed. Once this is complete, a Games Preservation Summit will be arranged to build a partnership momentum amongst the various interested parties to generate some momentum in this area.

This is an area with considerable potential for growth, and while this chapter outlines the position at the start of 2012, there is hope for a great deal of progress to be reported in the immediate future.

Discussion Topics

Computer Games Preservation: The Challenges

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Abstract. There are serious issues to be tackled from several angles of games preservation: the role of the developer in games preservation; the role of cultural institutions in terms of curation in general and metadata and documentation etc. in particular; and the role of the games community in preserving abandonware.

Keywords: Digital Preservation, Computer Games Preservation, Abandonware

1. Introduction

There were three breakout sessions covering:

- The role of the developer in curating and preserving games and virtual worlds;
- The role of cultural institutions: especially with respect to technical registries, metadata, software, hardware and online issues; interpretation and documentation;
- The role of the community: especially with respect to abandonware, orphan works, greyware; preserving Secondlife - content owners permission issues.

All participants joined in one of these sessions, which formed the heart of the symposium: practitioners, academic researchers and developers all working together to examine in depth the cutting edge issues facing games preservation from a variety of standpoints, and then presenting practical solutions to address these challenges.

2. The Challenges

From the Developers Standpoint:

From the key discussion between developers, academic researchers and those in memory institutions, some fundamental needs emerged. As a backdrop, it was important to explore the issues in terms of preservation in the games industry in order to establish the expectations coming from the memory institution / preservation side. This is so that those in industry will be able to determine the practicality of such requirements so as to determine what developers would need in terms of support to bring such ideas into fruition. There is a tendency for those in the private and public sector to have perhaps somewhat unrealistic expectations regarding what the private sector is both capable and willing to do under their various business pressures. In terms of a perfect world environment as preservationists, it is important to identify what are the key materials /

¹ Thanks here to Laura Fedden of the School of Creative Technologies for her support writing this chapter.

information that are needed but are not currently available? Are there lacunae in the actual games themselves, or their paradata, or the preservation process surrounding them?

First and foremost, provenance / ownership information is absolutely vital, so that researchers can access the work and memory institutions can catalogue it. A critical prerequisite to any research is to establish a controlled vocabulary for computer games, otherwise it is difficult to classify and specify the material in question. Terms like “first-person shooter” and “role-play” games need to be commonly understood and accepted across all relevant communities. Moving on to the data that particularly researchers require from developers, gameplay metrics and functionality stand out as key. Here companies like Bungie¹ and Infinityward² aid the researcher by providing the facility to record statistics within the game. With World of Warcraft³, a massively multiplayer online role-playing game (MMORPG), it is the socialization aspects of the game that are important to record, as well as technical run time data and requirements. Hence it is necessary to establish which techniques / type of data relate to which genres or groups of games.

Researchers will want the material that has been created in the studio to the point where a game is published; the algorithms, source code, storyboard, designs, maps etc.: indeed all the elements of the game itself. Walkthroughs of the game can be garnered from the gaming community who create this resource. Credits provide vital bibliographic data, but can only be obtained once the game has been completed. Quality Assurance documentation is required to show how the game should be run: at what pace, with what effects? If it is really robust, it will delineate how versions of the game progressed.

Given this preservation wish list, what can we realistically hope for from games developers, and how can we go about achieving these aims and objectives? Provenance / Ownership details are lacking for some older games, and this is a real problem in terms of IPR. But developers should be able to specify middleware. Going forward, there are ways developers can work today that will avoid the nightmare of abandonware reoccurring (see list below). Developers, like anyone else in industry, need a good business case to encourage them in this area.

What else can developers contribute? Here is a possible Developer’s Charter of what they could provide:

- The source code, documentation etc. to re-create the game build. This can be kept in an SVM (Support Vector Machine) repository, but there may be IPR issues.
- A list of the tools used to build the games. This could be provided in a Word document, and would include the build requirements specification. It would be not be too onerous for a developer to participate in this.
- The 3D engine models, and the pre-builds in 3D outside the game in 3D Max or Maya, together with the concept art or design documents. Access needs to be allowed to these artefacts.
- The Launch materials: press releases etc.
- The assets for the game, and the provenance of the game.
- The game objects such as the source code. It is possible to re-create a game from the components of the game, and there is the question as to whether the game objects

¹ <http://www.bungie.net/>

² <http://www.infinityward.com/>

³ <http://eu.battle.net/wow/en/>

are different from the final legal product as it takes a lot of effort to create a game from the components.

- The names of games workers so that they can be properly credited. The same applies to Middleware developers' credits.

From the Publishers' standpoint:

IPR is a serious issue with them, and it is difficult to get them to open up and discuss IPR issues freely. An excellent practical suggestion is to organise a conference / symposium for those in memory institutions to discuss the games IPR issues with specialist games IPR lawyers in order to try to breach this gap.

What are the issues for publishers? Publishers have games, and they need to be convinced of the benefits for them of preserving these games. Particularly with online distribution, publishers are realising the repercussions from developments such as the Wii store where Nintendo have been able to recycle all their previous console games and resell them back so old games still have live currency. But there are ways in which allowing access to games-related material can increase the marketability of a game in a manner that is attractive to publishers. For example, some individual games are offering design documentation as add-ons, e.g. Frictional Games did this with their Amnesia¹ game where they released stories, concept art and everything else actually buried within the game release. Taking this idea one step further, to access these products you are looking at those bottle necks in industry where the product goes through. With the way the Valve Corporation behind the Steam online store² now works, you can sell not just the game, but also the add-ons and the soundtrack on the same Steam page etc. So perhaps another approach, especially for the publishers who are so financially orientated, is to locally monetise the value of preservation in order to increase the amount of preservation happening within a monetised hub in industry. So effectively, to a large extent, Steam is the best game preservation portal currently in the world because they back date vast quantities of old games and other supplementary material.

Also, on the financial side, another interesting challenge for the preservation sector is the way companies like Apple have run the IOS store and kept developer prices down. So an old game can be owned and played individually for 99p, which is of the same order as a bus ticket to the centre of town to visit the local library, and that changes the economic balance as well. So rather than chasing after the IP which is potentially monetised, the issue is about looking for those alternative side products which cannot be monetised, or have too low a value to be able to support developers. If the potential future value of IP is an impediment to using preservation as a way of increasing the potential future value of IP, this would be very similar to the mod community in gaming where it goes back to Doom³. The stroke of genius here was to release it in the engine for free. When the whole engine went open source a few years later, when they later moved on and made a variation, what happened was if they made a game, it was played for three hours and then put down. However, if you mobilised 10,000 people online to make new levels for your game, its shelf life was kept around for much, much

¹ <http://www.amnesiagame.com/#main>

² <http://store.steampowered.com/>

³ <http://www.idsoftware.com/games/doom/doom-final>

longer, and additionally you kept the IP alive for longer. So maybe, if you have a game that is open access to preservation, you are not damaging the potential future IP, in fact you are increasing the potential future IP. There is also a project called ‘Humble Bundle’¹ where they collect four or five games between three months and a year old, put them together in a pack and place them on the Internet where you pay what you want for them. It transpires that if those games remain through standard paying channels at their original prices, not only do they make money, and even though you can pay just a small percentage to get this game, in fact sales go up on average about 25-30% on the online sites because the profile of the game increases. So there may be a point that there is a financial benefit to preservation, and to public preservation, because once sales have gone down to the point where a game is selling for 50 cents, because no one is going to buy it for \$15 anymore, then also being available for free could reverse the fortunes of the game and bring it back into profitability.

Many of the above points were also raised in the other two sessions, which are summarised below.

3. Curation: Cultural Institutions and Games Communities

How can these stakeholders work together?

Facilitating collaboration between eclectic communities kept emerging as a key practical issue. Computer games are now increasingly recognized as a part of our cultural heritage, as witnessed by the fact that growing numbers of national libraries are preserving such material as part of their legal deposit law remit. Such initiatives make it ever easier for the previously disparate communities to work together more closely, opening the way for specialist games archives, games museums, games developers and publishers, fan communities, and academic researchers to join forces with national libraries and other memory institutions. The JISC is also keen to collaborate, especially in the areas of shared infrastructure, common business models and metadata. This joint effort across all communities great and small should greatly increase our capability to preserve games. The associated issue of trust is also paramount: for example, publishers and developers need to be assured that their IPR is respected and protected by curators. The next topic to consider is: having hopefully preserved these games for posterity, what use will be made of them?

Who are we preserving these games for?

This is a complicated issue as there are potentially a myriad of different users wanting to use different games artefacts / paradata from a variety of standpoints. It is important to identify where the demand is coming from: who exactly wants to use computer games and related paraphernalia, and why, in order to ensure the correct material is available for them?

What do we preserve?

The spectrum of interest in different kinds of games-related material was very wide: indeed saving everything was mooted (a desire confirmed by the results of a survey carried out by the Royal Library, Copenhagen Denmark). Practically speaking, however,

¹ <http://www.humblebundle.com/>

it is impossible to preserve everything: some kind of filter needs to be applied. Several different aspects emerged here. First the performance aspect – how were the games played? What were the ludological elements of the games engineer? What was the psychological impetus behind the game, and what were the benefits of play? The story and narratives are also important components. It is vital to record the acts of playing computer games on particular hardware platforms, and videoing players / recording players on YouTube can play a key role here. For example, would researchers playing Quake¹ in 1,000 years time know about the Rocket jump? Information on interaction and immersion needs to be recorded. After all, we have very well preserved examples of physical Roman games, but not a clue how to play them. All aspects of games paradata were also deemed to be of great interest to various communities: fan fiction, wall art, exhibitions etc. Survivor stories from games developers are of interest: is there an equivalent of a war poet for games? The ethnographic aspect of games studies is also relevant, and it is important to reward developers who preserve their material, in the same way that the film industry led by Martin Scorsese preserved old films. There is deemed to be a conceptual shift from preservation to a live public games archive / museology. The games cover / box is a critical starting point for recording data, and other paradata such as MODs, discussions and competitions can all be downloaded from games sites.

Next, the imperative to save the computer hardware was established as crucial. A key question was: how many do we need of each piece of hardware – is three sufficient: one to use, one for spares and one for future use when the first breaks down? This was felt to be an absolute minimum. Detailed information on the hardware platforms is necessary in order to be able to emulate them. In big institutions such as broadcasting, there can be as many as 400,000 tapes and 10s of machines to play them on. In situations such as this, it is crucial to break down hardware issues into layers. For institutions that receive donated hardware, it needs to be established whether it is in working order? This is important for memory institutions such as the British Library that accept whole archives from games developers into their digital archives. Also, what are the significant properties of the hardware environment? Entropy comes into play here, and we should not get rid of hardware that we need, for example, to understand 3D objects. Collaboration with computer history museums can come into play here, as outlined in the chapter by Delve et al. What other steps are there to take all the above initiatives forward?

Pinchpoints in the process to harvest information have already been mentioned, along with Steam and other Apps stores, and games rating agencies. There are many examples of good practice, such as Moby Games who record thousands of games and related information in their database. Other practical suggestions include extending DROID to engage with disk images; working on systems identifiers that will persist across the various domains; and creating self-describing objects that could contribute to registries via automatic feeds. On the legal side, following on from Professor Ian Hargreave's recent contribution (Hargreaves, 2011)², international lobbying is needed, as taken forward by the KEEP project (Anderson, 2012)³. It is not always possible for large national institutions to lobby government, but those that can need to take up this issue, helped by influential games developers.

¹ <http://www.quakelive.com/#!home>

² <http://www.ipo.gov.uk/ipreview-finalreport.pdf>

³ http://www.keep-project.eu/ezpub2/index.php?/eng/content/download/20703/103715/file/D2.6_laymansguidelegalstudies_final.pdf

What about the problems of orphanware? A positive step here would be to reward developers / publishers who preserve their games. An interesting case study is Charles Cecil's (Revolution Software) "Beneath a Steel Sky"¹ which has no IPR attached. This included a virtual machine and the response to the game was very good indeed. It was distributed by scummVM², amassed many sales and was easy to preserve, having been released to the games community, then re-released commercially. The quality of the games are important here: "Beneath a Steel Sky" was successfully preserved because it was so good: mediocre games may not have fared so well. Similarly, rare games may be seen as being worthy of special attention. But we need to preserve games that failed as well as the top ones, so perhaps a multi-community-based ranking system of games might be useful? Attention also needs paying to where games appear and under which marketing strategy: for example, games available on the front of magazines might easily be overlooked. A Noah's Ark of games might be something to aim for, with representative samples of different games genres etc.

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¹ <http://www.revolution.co.uk/skyr/support>

² <http://scummvm.org/downloads/>

Appendix

Biographical sketches for authors (in alphabetical order)

Professor David Anderson is a professor of Digital Humanities, CiTech Research Centre Director, and co-leader of the Future Proof Computing Group, at the University of Portsmouth. He holds a B.A. Hons in Philosophy (QUB) and a Ph.D. in Artificial Intelligence (QUB). His research interests include: digital preservation, history of computing, paraconsistent logic, epistemology, artificial intelligence and the philosophy of mind. He was the UoP Principal Investigator for the EC FP7 Project KEEP. In addition to being the Editor in Chief of the Taylor & Francis journal, *The New Review of Information Networking*, David has served on numerous international committees including the IEEE Publications committee. He is a member of the AHRC Peer Review College.

Professor Richard Bartle is Senior Lecturer and Visiting Professor of Computer Game Design at the University of Essex, UK. He is best known for having co-written in 1978 the first virtual world, MUD, and for his 1996 Player Types model, which has seen widespread adoption by the MMO industry. His 2003 book, "Designing Virtual Worlds", is the standard text on the subject, and he is an influential writer on all aspects of MMO design and development. In 2010, he was the first recipient of the prestigious GDC "Online Game Legend" award.

Winfried Bergmeyer studied art history, European ethnology and archaeology at the Universities of Marburg and Zurich. He worked at the Saxonian Cultural Heritage Service in Dresden. After advanced training as manager for online-marketing in 1999 he worked as project coordinator at the LuraTech GmbH in Berlin and thereafter as scientific assistant at the Institute for Museum Research. Since May 2009 he has worked at the Computerspiele Museum in Berlin. He is coordinator of the working group "Langzeitbewahrung" as part of the German museums association.

Clive Billenness holds the post of EC Project Management Expert at the British Library. He is currently the Project Manager for POCOS and also a workpackage lead on the EC FP7 Project KEEP as well as a member of the British Library's project team on the EC FP7 Project SCAPE. Qualified in Prince2, MSP and M_o_R, Clive was the Programme Manager of the Planets Project and a member of the team which created the Open Planets Foundation. He is a Certified Information Systems Auditor. As a Head of the Northern Region's Public Sector Information Risk Management Team at KPMG LLP, Clive was responsible for directing a review on behalf of the National Audit Office of the £30m project to update the Department of Work and Pensions computer systems. He also advised the UK Office of Government Commerce and the Office of the UK Deputy Prime Minister on a number of IT Projects. Prior to this, Clive was a Regional Service Lead for the Audit Commission where he was frequently loaned to clients to assist with the recovery of projects which were in exception. Clive is a member of the Office of Government Commerce's Examining Board for Project, Programme and Risk Management examinations. He is also a Director of the UK Best Practice User Group for the same disciplines. Clive is a regularly published author for the Chartered Institute of Public Finance and Accountancy (CIPFA) on Project Management.

Angela Dappert (Digital Preservation Coalition), is Project Officer for the EU TIMBUS Project. TIMBUS is about digital preservation of timeless business processes. She also serves on the PREMIS Editorial Committee. In both capacities she is involved with the issues of modelling and defining metadata for computational environments. She has worked at the British Library on data carrier stabilization, digital asset registration, preservation planning and characterization, eJournal ingest, and digital metadata standards. Before this she worked for Schlumberger, the University of California, Stanford University and Siemens. Angela holds a Diploma in Medical Informatics from the University of Heidelberg and an M. Sc. In Computer Sciences from the University of Texas at Austin.

Janet Delve is co-leader of the Future Proof Computing Group, one of the research clusters in the Centre for Cultural and Industrial Technologies Research (CiTech) at the University of Portsmouth. She holds degrees in Mathematics (UCL), French (Southampton), together with a Master's degree in Microwaves and Modern optics (UCL), and a PhD in the History of Mathematics (Middlesex University). Her research interests include: metadata modelling for digital preservation; data warehousing applied to cultural domains; and the crossover between the history of computing and digital preservation. The University of Portsmouth is a partner in the EC FP7 Project KEEP, in which Janet is responsible for the data modelling of complex digital objects and the development of the technical environment metadata database, TOTEM. She is a member of the AHRC Peer Review College.

Jerome McDonough is an Associate Professor in the Graduate School of Library and Information Science at the University of Illinois at Urbana-Champaign. He holds a Ph.D. in Library and Information Studies from the University of California at Berkeley, and his current research focuses on metadata and digital preservation. He is currently the Principal Investigator for the Preserving Virtual Worlds 2 project, an investigation into the significant properties of computer games funded by the Institute of Museum & Library Services. Prior to joining the faculty at GSLIS, Prof. McDonough was the head of the Digital Library Development team for New York University Libraries. He has served on the NISO Standards Development Committee, as well as serving in various metadata standards efforts for libraries, including the METS digital library standard and the PREMIS digital preservation metadata standard.

Professor James Newman is Professor of Digital Media, Course Leader in Creative Media Practice and Director of the Media Futures Research Centre at Bath Spa University. He researches, writes and teaches on digital media, videogames and the cultures of play and has written numerous books on videogames and gaming cultures for publishers including Routledge and the BFI. James is a co-founder of the National Videogame Archive which is a partnership with the National Media Museum, the UK's official collection of videogames and the ephemera of games culture, and a member of the European Federation of Game Archives, Museums and Preservation Projects (EFGAMP).

James is a co-producer on the GameCity international games festival and sits on the board of the gaming culture Special Collection of the UK Web Archive. James latest book, 'Best Before: videogames, supersession and obsolescence' was published by Routledge in 2012 and is the first book-length project tackling issues of game history, heritage and digital media preservation.

Dan Pinchbeck is Creative Director of thechineseroom, an independent game development studio based in Brighton and Portsmouth, UK. Their first game, Dear Esther will be released on Steam on 14th February 2012. Beginning life as a research project, then a Source mod, Dear Esther has gathered multiple international awards, critical acclaim and a dedicated following since it was first conceived in 2007. thechineseroom have also released another source mod, the cult horror Korsakovia. They are currently working on two new games, the top secret survival horror GameB, and Everybody's Gone to the Rapture. This is an openworld game exploring new narrative techniques and is groundbreaking as a UK Research Council funded project to explore commercialisation as a means of enabling development-led games research in Higher Education.

In his other life, Dan is Reader in Computer Games at the University of Portsmouth, UK, where he teaches game design. He holds a PhD in First-Person Gaming, and has published internationally on experimental game design, independent game development, story and gameplay, and game preservation. His first book, DOOM: scarydarkfast will be published by the University of Michigan Press as part of their Landmark Videogames Series in 2012.

Iain Simons is the Director of the GameCity festival at Nottingham Trent University. He has written and talked about videogame culture for a wide variety of audiences and publications. In 2008 he co-founded the National Videogame Archive, a unique collection of Videogame software, hardware and ephemera.

Paul Wheatley is a specialist in digital preservation and works for the University of Leeds. He is educated in Computer Science and has previously worked for the British Library, and as a technology journalist & software developer.

Paul has played a leading role in various collaborative digital preservation developments at the University of Leeds, including the Camileon project, which gained international recognition for helping to rescue the BBC Domesday system using emulation technology.

Tom Woolley became the National Media Museum 's first Curator of New Media in 2007, and is now responsible for the Museum's youngest Collection. Before joining the Curatorial team, Tom directed the Bradford Animation Festival (BAF). He has a background in multimedia design, having graduated from the University of Bradford in 2002 with a BSc in Electronic Imaging and Media Communications. Tom has been establishing and expanding the New Media collection to illustrate the development of digital media, with particular focus on the internet, home computing and videogames. In 2010 he curated the Robbie Cooper: Immersion exhibition and the Games Lounge display in the Museum foyer. In 2008 he helped to establish the National Videogame Archive in partnership with Nottingham Trent University. Tom programmes BAF Game, the games strand of the Bradford Animation Festival. BAF Game aims to help students connect with the videogames industry and showcases gaming's creative culture. Tom is lead curator on the forthcoming Life Online - a new permanent gallery that will explore the history and social impact of the Internet.

Glossary

- Access:** the process of turning an *AIP* into *DIP*, ie using data from a digital archive
- ADF Opus:** A Microsoft Windows-based program to create *ADF*
- ADF:** Amiga Disk File, a file format used by Amiga computers and emulators to store images of disks
- ADS:** Archaeology Data Service, a digital archive specialising in archaeological data based in York
- AHDS:** Arts and Humanities Data Service, a data service for higher education, closed in 2008
- AIMS:** Project funded by Mellon foundation to examine archival principles in the digital age
- AIP:** Archival Information Package, a package of information held within an *OAIS*
- APA:** Alliance for Permanent Access, a European network, set up *APARSEN*
- APARSEN:** a Network of Excellence funded by the *EC*, see *APA*
- API:** an interface provided by a software program in order to interact with other software applications
- Archival Storage:** The *OAIS* entity that contains the services and functions used for the storage and retrieval of *AIP*
- ARCOMEM:** ARchive COmmunities MEMories, *EC*-funded project in digital preservation
- ASCII:** American Standard Code for Information Interchange, standard for electronic text
- BADC:** British Atmospheric Data Centre
- BL:** British Library
- BlogForever:** *EC*-funded project working on robust digital preservation, management and dissemination facilities for weblogs
- BLPAC:** British Library Preservation Advisory Centre – a service of the BL which promotes preservation
- BS10008:** a British standard pertaining to the evidential weight of digital objects
- CCSDS:** Consultative Committee for Space Data Systems, originators of the *OAIS* standard
- CD-ROM:** Compact Disc, read-only-memory
- Characterisation:** stage of ingest processes where digital objects are analysed to assess their composition and validity
- Checksum:** a unique numerical signature derived from a file. Used to compare copies
- CiTech:** Centre for Cultural and Industrial Technologies Research
- Cloud (cloud-computing, cloud-based etc.):** on demand, offsite data storage and processing provided by a third party
- CRT:** Cathode ray tube
- CSP:** Compound Scholarly Publication
- CVS:** Concurrent Versions System or Concurrent Versioning System, a client-server revision control system used in software
- Data Dictionary:** A formal repository of terms used to describe data
- DCC:** Digital Curation Centre, data management advisory service for research
- DDC:** Dewey Decimal Classification
- Designated Community:** group of users who should be able to understand a particular set of information

DigiCurVE – Digital Curation in Vocational Education, assessment project funded by EU on training provision in Europe

Digital Object: a set of bit sequences, e.g. a single document such as a PDF file, or an image of a (console) game, etc.

DIP: Dissemination Information Package, the data disseminated from an *OAIS*

DOS: Disk Operatins System

DP: Digital preservation

DPA: Digital Preservation Award, biannual prize awarded by the *DPC*

DPC: Digital Preservation Coalition, a membership body that supports digital preservation

DPTP: Digital Preservation Training Programme, an intensive training course run by *ULCC*

DRIVER: Digital Repository Infrastructure Vision for European Research

DROID: tool developed and distributed by TNA to identify file formats. Based on *PRONOM*

DSA: Data Seal of Approval, a process by which organisations can undertake self-evaluation of their DP practices

DVD: Digital Versatile Disk, formerly the same abbreviations was used for Digital Video Disk

EC: European Commission

Edina: a national data centre based in Edinburgh University mainly funded by JISC

Emulation Framework: a framework that offers emulation services for digital preservation

Emulation: adapts a computer environment so that it can render a software artefact as if it were running on its original environment

Encapsulation: a process where digital objects are captured with information necessary to interpret them

ENSURE: Enabling kNowledge Sustainability Usability and Recovery for Economic value, *EC*-funded project

EPSRC: Engineering and Physical Sciences Research Council, UK

EU: The European Union

FOAF: Friend of a friend, machine-readable ontology describing persons

FRBR: Functional Requirements for Bibliographic Records

GD-ROM: Giga Disc Read Only Memory, proprietary optical storage medium for the game console Sega Dreamcast

GIF: Graphic Interchange Format, an image which typically uses *lossy compression*

GIS: Geographical Information System, a system that processes mapping and data together

HATII: Humanities Advanced Technology and Information Institute at Glasgow University

HDD: hard disk drive

HEI: Higher Education Institution

HTML: Hypertext Markup Language, a format used to present text on the World Wide Web

IGDA: International Game Developers Association

Incremental: a project funded by *JISC* at HATII and Cambridge University

Ingest: the process of turning an *SIP* into an *AIP*, ie putting data into a digital archive

ISO: International Organization for Standardization, body that promotes standards

JISC: Joint Information Systems Committee of the Higher Education Funding Councils

- JPEG 2000:** a revision of the *JPEG* format which can use *lossless compression*
- JPEG:** Joint Photographic Experts Group, a format for digital photographs which is *lossy*
- KB:** Koninklijke Bibliotheek, national library of the Netherlands, partner in *KEEP* and *APARSEN*; *APA* home to *LIBER* and *NCDD*
- KEEP:** Keeping Emulation Environments Portable, EC-funded project to develop *emulation* services to run on a virtual machine
- KVL:** King's Visualisation Lab
- LC:** Library of Congress
- LCD:** Liquid Crystal Display
- LED:** light emitting diode
- LIBER:** network of European Research Libraries involved in *APARSEN* and *AP*, offices at the *KB*
- LIDAR:** **Light Detection And Ranging**, an optical remote sensing technology used to measure properties of a target using light or laser.
- LiWa:** Living web archives, EC-funded project which developed web archiving tools
- LOCKSS:** Lots of Copies Keeps Stuff Safe a DP principle made into a toolkit for E-Journal preservation, see *UKLA*
- LOD:** Linked Open Data
- Lossless compression:** a mechanism for reducing file sizes that retains all original data
- Lossy compression:** a mechanism for reducing file sizes which typically discards data
- MANS:** Media Art Notation System MANS
- Memento:** an innovative tool which allows time based discovery of web pages, winner of *DPA 2010*
- METS:** Metadata Encoding and Transmission Standard, a standard for presenting metadata
- Migration:** the process of moving data from one format to another
- MLA:** Council of Museum Libraries and Archives, strategic body for such organisations in England
- MP3:** digital audio format (standing for both MPEG-1 or MPEG-2 Audio Layer III)
- NARA:** US National Archives and Records Administration
- NCDD:** Dutch national digital preservation coalition, closely aligned with *APA*, *DPC* and *Nestor* and hosted by *KB*
- NDAD:** UK National Digital Archive of Datasets, formerly funded by *TNA* and operated by *ULCC*
- NDIIPP:** National Digital Information Infrastructure and Preservation Programme – a major programme from the *LC*
- Nestor:** German network of expertise in digital preservation, closely aligned to *APA* and *NCDD*
- NRW:** North Rhine-Westphalia, state of Germany
- OAI-ORE:** Open Archives Initiative Object Reuse and Exchange, standards for description and exchange of web resources.
- OAI-PMH:** Open Archives Initiative Protocol for Metadata Harvesting
- OAIS:** Open Archival Information System, a reference model describing a digital archive
- OCLC:** Online Computer Library Center, Inc., US-based library and research group
- OMII-UK:** open-source organisation that empowers the UK research community by providing software for use in all disciplines of research
- Open source:** software in which the underlying code is available for free
- OPF:** Open Planets Foundation, a membership organisation which sustains outputs from the *PLANETS* project

OSS: Open Source Software

Paradata: Information about human processes of understanding and interpretation of data objects, e.g. descriptions stored within a structured dataset of how evidence was used to interpret an artefact.

PARSE.INSIGHT: EC-funded project that developed a roadmap for DP infrastructure in Europe

PDF/A: a version of the PDF standard intended for archives

PDF: Portable Document Format, a format for producing and sharing documents

PLANETS: a project funded by the EC to develop a suite of DP tools including *PLATO*. Now maintained by *OPF*

PLATO: a *preservation planning* tool which was created by the *PLANETS* project

PNM: Preservation Network Model

POCOS: Preservation Of Complex Objects Symposia, a JISC-funded project which organised a series of three symposia on preservation of Visualisations and Simulations; Software Art; and Gaming Environments and Virtual Worlds in 2011-12

PREMIS: Preservation Metadata: Information Strategies, metadata standard

Preservation planning: defining a series of preservation actions to address an identified risk for a given set of *digital objects*

PrestoPRIME: EC-funded project which develops tools and services for the preservation of digital audio-visual content

PRONOM: a database of file formats with notes on associated issues. Used with *DROID*

PROTAGE: Preservation organizations using tools in agent environments, EC-funded project

PSD: Adobe PhotoShop file format

RCUK: Research Councils UK

RDF: Resource Description Framework

RIN: Research Information Network, a group that studies and reports on research needs

RLG: Research Libraries Group, US research group that produced *TDR*. Now part of *OCLC*

RLUK: Research Libraries UK

SaaS: software as a service, architecture whereby software is managed remotely by a service provider (see also *cloud*)

SCAPE: Scalable Preservation Environments, EC-funded project developing scalable preservation actions

SHAMAN: Sustaining Heritage Access through Multivalent Archiving, EC-funded project

Significant properties: concept whereby identifying the most important elements element of a file will aid preservation

SIP: Submission Information Package, data received into an *OAIS*

SKOS: Simple Knowledge Organization System, specifications on knowledge organisation system, developed by W3C

SPEQS: Significant Properties Editing and Querying for Software

SSMM: Software Sustainability Maturity Model

STFC: Science and Technology Facilities Council, UK

STM: Science Technology and Medicine – major area of publishing, sometimes meaning the STM Publishers Association

SWISH: joint venture between *RCAHMS* and *RCAHMW* to provide digital services including long term preservation

- TDR:** Trusted Digital Repository, a standard which characterises ‘trust’ in a digital archive
- TIFF:** Tagged Image File Format, a common format for images typically *lossless*
- TIMBUS:** an EC-funded project which is investigating the preservation of online services
- TOTEM:** Trustworthy Online Technical Environment Metadata Database
- TRAC:** Trusted Repository Audit and Certification, toolkit for auditing a digital repository
- UBS:** universal serial bus
- UKDA:** UK Data Archive University of Essex, digital archive for social and economic data
- UKLA:** UK LOCKSS Alliance, a service of *Edina* which offers E-journal preservation
- UKWAC:** UK Web Archiving Consortium
- ULCC:** University of London Computer Centre, host of *NDAD* and creators of *DPTP*
- UMD:** Universal Media Disc; proprietary CD-ROM format of Sony Computer Entertainment
- UML:** an industry standard for visualisation, specification construction and documentation of artefacts of software systems
- UNESCO:** United Nations Educational, Scientific, and Cultural Organization: an agency of the United Nations supporting programmes to promote education, media and communication, the arts, etc.
- VHS:** Video Home System, videocassette recording technology
- Virtualization:** creation of a virtual rather than actual instance of software or hardware (see also *emulation*)
- VRML:** Virtual Reality Modelling Language, file format for representing 3D graphics
- W3C:** World Wide Web Consortium
- WF4EVER:** Advanced Workflow Preservation Technologies for Enhanced Science, EC-funded project
- WinUAE:** Amiga emulator supporting 5.25" and 3.5" double density disks and 3,5" high density floppy disks
- XML:** Extensible Markup Language, a widely used format for encoding information



Preservation of Complex Objects Symposia



Participating project partners:



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