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The Australian Emulation Network: Accessing Born Digital Cultural Collections

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Abstract

This paper outlines a new funded project which aims to conserve and render born digital artefacts widely accessible by establishing an Australian Emulation Network. High value cultural collections from university archives and the GLAM sector requiring legacy computer environments will be targeted. The project expects to generate new knowledge across media arts, design, and architecture. Expected outcomes include stabilising and providing researchers with emulated access to born digital cultural artefacts, sharing legacy computer environments across the network, and establishing an Australian software preservation community of practice, building skills in preserving and emulating digital cultural artefacts with substantial future applications also in scientific preservation.

Keywords

Media arts preservation; digital infrastructure; emulation; Emulation as a Service Infrastructure (EaaSI); software preservation; digital preservation.

Introduction

Australians were – and continue to be – significant contributors to the development of digital media arts, design, and architecture internationally. But our digital art and design history of the last thirty or more years is fragile and largely inaccessible to researchers at present, having only recently begun to make its way into cultural institutions and other archives. Such born digital artefacts constitute the record of how we became digital, from earliest endeavours right through to very recent history. The risk of losing this heritage material is real. This project will stabilise these collections so they are not lost, and make these digital creative and cultural artefacts accessible, through emulation. The physical media on which legacy digital objects are stored – whether magnetic or optical (i.e. floppy disks, CD-ROMs) – deteriorate over time. Obsolescence of computing environments is also a significant problem. Once computer hardware, operating systems and utility software become obsolete, files and other software dependent artefacts cannot be opened or run without digital preservation interventions. The solution to these twin problems involves the creation of disk images of obsolete media carriers, which can then be run under emulation. Emulation simulates the function of obsolete systems and is a key digital preservation strategy for accessing content. These are now widely accepted solutions. For example, the British Library aims to image its entire disk collection, making it available to users in its Reading Rooms [1]. While not trivial, the two-part operation – imaging and making collections available through emulation – is eminently feasible. Realising the scale of the task, digital preservationists agree that international networked, collective action is a must [2], with CSIRO advising "Digital preservation urgently requires coordinated, national, cross-sector approaches to avoid losing access to historical digital materials" [3].

This project is rooted in both international collective action and national, cross-sector collaboration. We will join recent international infrastructure developments – notably the Emulation-as-a-Service Infrastructure platform (EaaSI) – together with the learning that our team has gained from research and practice in disk imaging [4]–[6]. We will assemble 'end-to-end' software preservation infrastructure in Australian university and GLAM (Galleries, Libraries, Archives and Museums) institutions: this will enable an organisation that currently cannot access a file or an artwork to create disk images and emulate these in house.

Disk Imaging and Emulation

The first part of the process involves creating disk images. Previous work has shown that disks that have not been kept in ideal circumstances fail at a higher rate to those stored in climate controlled conditions (61% to 94%), highlighting the perils that legacy collections with non-optimal storage histories face [4]. One Stanford study found optical media was failing at an alarming rate, with only an 8% success rate imaging CD-ROMs [7].

The second step is to emulate imaged content. Developed by computer scientists at Freiburg University, the Emulation-as-a-Service (EaaS) platform provides access to obsolete computer environments (hardware, operating systems (OSes)) enabling legacy software and other complex digital artefacts to be emulated and accessed by users in a web browser. The most developed emulation solution, EaaS is being used or evaluated at a number of institutions, including Rhizome, the Tate, the Canadian Centre for Architecture (CCA), and the Dutch Digital Heritage Network [8]–[11]. We are currently using it in Australia in two ARC Linkage Projects lead by the author –

"Play It Again: Preserving Australian videogame history of the 1990s" (LP180100104) and "Archiving Australian Media Arts: Towards a best practice method and national collection" (LP180100307) – where it has proven a very valuable tool for rendering the complex digital artefacts we are working with: 1990s games and 1980s and 90s digital media art. Funding from the Sloan and Mellon Foundations to Yale University has enabled a group of US university libraries to develop a networked version, called EaaSI (EaaS Infrastructure). EaaSI delivers a scalable emulation service, linking US libraries with born digital collections into a decentralised network where they can not only emulate content in house, but also share images of utility software and preconfigured legacy environments with other library nodes [12]. For instance, if a manuscript in one library requires an environment of Word 7 running in Windows 95, an administrator can search for and download the environment someone else has configured, saving time and resources.

Access to the EaaSI platform is now being offered via a hosted pilot through the Software Preservation Network (SPN) [13]. This pilot brings together over 15 US university libraries and archives such as Yale, Harvard, Stanford and Cornell University, which will use EaaSI to share configured environments. SPN is a membership organisation which our partners AARNet and the National Archives of Australia have joined, together with these North American organisations keen to access the hosted pilot. SPN's pilot is similar to what we will build. A gateway provides computing power remotely, tracking users and environments and managing resources (RAM and CPUs) as needed, so that minimal IT resources are required from an organisation wanting to run EaaSI in house. Controller computers are used by node administrators to build environments in EaaSI's backend, and users access emulated artefacts via a webpage [14]. Such a setup was envisaged by EaaS's creators as early as 2014, when they wrote of "an EaaS service-provider [being] responsible for efficient hardware utilization and concentration of technical expertise…[lightening] the memory institutions' technical workload and requirements on necessary infrastructure" [15].

Network Participants and Aims

The project comprises universities (Swinburne University of Technology, RMIT, the University of Melbourne, University of South Australia, Western Sydney University, the University of Western Australia, and the University of New South Wales), National and State Libraries, other major cultural institutions (the Australian Centre for the Moving Image (ACMI), the Museum of Applied Arts and Sciences (MAAS), the Art Gallery of New South Wales (AGNSW), the Australian Institute for Aboriginal and Torres Strait Islander Studies (AIATSIS), and the National Archives of Australia (NAA)), software archives (the Australian Computer Museum Society), a research

technology provider (AARNet), and supporting overseas partners (Yale University, OpenSLX, Cornell University). This grand consortium is necessary as the market has failed to ensure that legacy content can be accessed, and most libraries and other archives in Australia lack the requisite infrastructure and know how. We propose to set up a network of fifteen university and GLAM sites across Australia. This will be a major national facility. Nodes will be located at the sites where digital creative and cultural collections are held. Setting up a network of organisations leverages collective effort and makes good financial sense [16]. The consortial approach builds on: existing networks such as the peak body National and State Libraries Australia (NSLA), collaborative work packages NSLA has undertaken [17], as well as previous projects in which Chief Investigators have been involved: Anna Munster and Sean Cubitt on "Reconsidering Australian Media Art History" (LP100200442) which produced the "Scanlines: Media Art in Australia since the 1960s" database [18], Harriet Edquist on "Design and Art Australia Online" (LE140100120), and Swalwell's "Creative Micro-computing in Australia, 1976-92" Fellowship (FT130100391). Finally, the project directly benefits from the two aforementioned project collaborations involving installations of EaaS (at Swinburne, ACMI, AGNSW, and AARNet), and the specialist personnel associated (Dr Cynde Moya). The project has secured Australian Research Council LIEF (LE220100057) funding for infrastructure in the form of specialist expertise, vintage soft and hardware, cloud computing, storage, and tools to preserve, emulate, and share software resources across the nation, according to different organisations' needs. The project will – through a combination of technical infrastructure and knowledge transfer – deliver software preservation and emulation capabilities across 6 of the 8 states and territories, with a high likelihood of future growth.

Joining together, we will build nationally significant digital heritage infrastructure, creating a network of technology, people, and emulation nodes seeded with legacy software and preserved content. Specifically, we aim to:
1. Stabilise at risk media arts and similar born digital cultural artefacts;
2. Deliver access to born digital cultural and artistic artefacts to researchers over an EaaSI network;
3. Develop a Community of Practice (CoP) for software preservation in Australia, building skillsets and confidence in preserving and emulating digital artefacts.

Targeted Collections

We will stabilise and emulate culturally significant media arts, architecture and design collections. We target at risk born digital creative and cultural collections across five key domains: (1) media arts; (2) architecture and industrial design; (3) games and apps; (4) AR/VR; and (5) web and pre-web networking. These digital collections constitute key research resources which CIs and their teams require access to. As Sean Cubitt and Oliver Grau wrote of media art in 2011: "As a result of rapid changes in technology, many

major works made even 10 years ago can no longer be shown or are disappearing without a trace. If this situation is not addressed, we face losing an art form that is a central part of our post-industrial digital culture. To date, systematic global preservation and documentation campaigns do not exist" [19]. Part of the Media Arts Histories conference series, the so called "Liverpool Declaration" received some 237 signatures from artists, theorists, and curators, internationally. Cubitt and Grau's assessment holds equally for other domains. Content is either already inaccessible, often at risk of being lost, or fast becoming inaccessible.

While the collections we will work with are disparate, a decentralised network of organisations and collections is precisely what EaaSI has been built to service. What these collections demonstrate is a new focus on distributed collections across the nation, similar to what is seen in the UK AHRC's "Towards a National Collection: Opening UK heritage to the world," attracting an £18.9 million investment [20]. The inter-relationships that will surface between the collections will be one of the most exciting aspects of the research that this infrastructure investment will enable. That diverse collections will be rendered accessible through a single platform should augment their usefulness to researchers.

Significance and Benefit

Access to the abovementioned content will enable CIs and their teams to lead genuinely transformational research in born digital cultural histories, across the five domains. Few Australian researchers currently have access to born digital artefacts once computing environments become obsolete, unless they are running an emulation solution themselves. This means that scholars who are commenting on contemporary digital productions, for instance, are doing so without access to digital process or historical antecedents. Rendering these sources accessible will genuinely change what it means to undertake research. Rather than relying on second hand textual accounts or memory, researchers will be able to re-access historic titles or even previously out of reach design drawings, bringing new perspectives to historic and contemporary analyses. Emulation capabilities will generate new forms of evidence, citation – as has already started to happen in video game history [21] – and transformative methodologies. For e.g., architectural and design historians need new methodologies based in artefact analysis to account for the shift to digital design and modelling and the drift toward digital methods of documentation, from the mid-1990s.

We will build a technical and human network, training GLAM and university archival professionals with the skills they need so that the high value archival collections in their custody can be stabilised and rendered accessible. The project is premised on a conception of infrastructure as involving both people and technology. While the Australian GLAM sector has been developing digital preservation capacities, this has often targeted the 'low hanging fruit' of digitisation. Despite concerns about the greater fragility and

time criticality of stabilising born digital artefacts, progress has been much slower, particularly as regards software-dependent artefacts. These have often been placed in the 'too hard basket,' due to a lack of specialist skills and infrastructure. Each organisation is at a different stage of maturity in its ability to deal with complex born digital artefacts. We will train staff from nodes in universities and the cultural sector in how to create disk images where such training is required, or simply in how to build emulation environments in the EaaSI backend. We will seed the development of a CoP by running web forums and seminars where practitioners can share their learning and ask questions, leveraging novel solutions to problems developed by those with more experience.

A Community of Practice will build confidence in the GLAM sector around born digital collecting. Existing GLAM infrastructure has not allowed for collecting or providing access to much of our contemporary digital heritage. This project establishes a CoP, which includes training in imaging and emulating such artefacts, as well as ongoing mutual support with the varied creative and technological challenges. This is critical professional development for the 2020s that will complement what is learnt in library and archival science and conservation degrees. The Australasia Preserves community is committed to the support of digital preservation strategies in Australian and New Zealand institutions, and recent activity indicates strong interest in an EaaSI network across Australian institutions [22]. The establishment of such a specialist network will give our partner archives and others in the sector the confidence they need, making future collecting of digital design, including mobile applications, video games, social media, design and engineering documentation seem more feasible. This will in turn enable research into new forms of digital sociality and cultural production, such as app cultures and algorithms.

Deploying the EaaSI platform enables legacy software and configured environments to be shared between nodes. Software products are both cultural artefacts worthy of study and enabling infrastructure for accessing digital content. Often, born digital files have been collected without the software required to open the files, or the operating system required for utility software to run. The process of building emulation environments is streamlined by the ability to share imaged software and configured environments. In addition, sharing effectively eliminates competition for purchasing scarce, second-hand software products. Emulation is now a viable strategy with a clear legal framework for use in Australian institutions. Recent changes to the Copyright Act (the "Research Exception", in s 113J) permit a library or archive as defined in the Act to make research copies of copyright materials and to make these copies available to be accessed at the library or archive or another library or archive, provided certain conditions are met. Partners across the EaaSI network will have access to a range of collections of utility software from sites including the Australian Computer Museum Society and the National Library of Australia.

CIs will further develop partnerships with others in the emulation field, for mutual benefit. Currently, Australian media art is probably being studied more in overseas contexts than at home. For instance, Dr Dene Grigar of the Electronic Literature Lab at Washington State University has hosted several artists to discuss and play their work. Dr Megan Heyward visited to make a "traversal" in 2019 – a technique of interviewing people with their artwork running on original hardware – and it was the first time she had been able to access "Of Day of Night" (1996) in almost twenty years. Video traversals constitute a useful form of documentation but they are imperfect as a method of preserving what are inherently interactive works. Not many of these labs are pursuing emulation, so they will likely find themselves unable to access work in the future. Cornell University is an exception. It has been one of the leaders in the US. Prof Timothy Murray wrote widely about and collected CD-ROM art when it was still contemporary, curating the Rose Goldsen Archive in the Cornell University Library; the Library developed a widely lauded online digital preservation tutorial; pioneered good practices in the archiving and emulation of digital media art in an NEH-funded preservation project [23]–[26]; now they are a participant in the SPN hosted pilot of EaaSI. Norie Neumark is keen to explore international research and exhibition opportunities between the various Australian and US based collections. Similarly, the Canadian Center for Architecture (CCA) is working with Yale to implement EaaSI into their access workflows for born-digital material, specifically building it into their access interface SCOPE. Gaining access to our born digital heritage content now will position Australian researchers to lead debates in our respective fields of historic media arts, born digital design and architecture, and what emulation means for them. Continued contact with other international leaders – such as the CCA and Cornell – will enable us to develop new collaborations, and put Australian artefacts in international context.

While many born digital artefacts are historic, this infrastructure is about the future as much as the past. Rapid obsolescence is making access to relatively recent VR works challenging. Digital work practices are now integral in fields such as architecture, and the future of practice in other fields is similarly digital, presenting challenges in archiving including establishing rationales for preservation, archiving processes and achieving digital continuity. Future historians are going to require access to much contemporary media (e.g. social media) in order to do their work. While digital connectivity has come to the fore during Covid-19 lockdowns and there has been some focus on rapid collecting in relation to the 2020 pandemic (e.g. at NAA's "Documenting Covid-19 in Australia" (2020) symposium), born digital materials acquired now will need appropriate computing environments to remain accessible into the future.

The Emulation Network will span academic and GLAM institutions, leveraging existing network infrastructure operated by AARNet. CIs and their teams will either access EaaSI within GLAM reading rooms on the premises, or on university premises. Future copyright reforms that are anticipated but not yet enacted may enable organisations to offer remote access to authenticated users in the future [27].

Building software preservation and emulation infrastructure in Australia will have far reaching benefits for CIs, their teams, and the broader research community. While the project focuses on art and cultural domains, the technological and methodological development will have applications across all areas that use and need to study interactive systems. Inevitably, other software dependent collections and datasets will be identified at the universities and partner organisations which the infrastructure can be used to stabilise and emulate, including historical artefacts in education, social sciences and empirical data-rich science. This is in alignment with FAIR data principles, which emphasise that data should be Findable, Accessible, Interoperable, and Reusable [28] and will have important benefits for reproducible science, including software required to reproduce computationally dependent research results. Bodies such as OSF (Open Science Foundation) encourage the publication of complete research works – that is, an integrated set of data, analytical code, results and interpretation that can be re-run and modified at will by future readers and researchers. This clearly requires solving the same issues of long term change in hardware, OS and software that we are addressing in this project.

Stabilisation of obsolete storage media is an area of great need. Collections are at risk with the National Film and Sound Archive noting the "consensus among audiovisual archives internationally that we will not be able to support large-scale digitisation of magnetic media in the very near future. Tape that is not digitised by 2025 will in most cases be lost forever" [29]. Born digital components bring special preservation and access challenges: videotape degrades, magnetic computer disks suffer bit rot, computer hardware quickly becomes obsolete, and software dependencies present special access challenges. Time is of the essence if we are to prevent the loss of digital heritage, protecting the investment Australia has already made via arts funding. And as already noted, an emulation solution is not just needed for archiving the past, but increasingly for accessing recent scholarship, and for contemporary and future digital cultural collections.

Many organisations are grappling with how to develop a full production process for users who encounter content that requires emulation in their collections and need to use it for informational purposes. Yet few institutions have the infrastructure or skills to offer researchers access to born digital artefacts requiring emulation. This project's focus on emulating obsolete software is identical to the needs of such users and readers. If we are to develop a capacity to safeguard digital collections in Australia, then we must work together, both across the sector and with those who have developed platforms internationally. We need to train a cohort of skilled people and support them with a CoP. We intend to do just that, giving the often professionally siloed GLAM professionals – archivists, librarians, and

conservators – a place where they can turn for help when they run into challenges.

Finally, EaaSI has the potential to complement and increase capability within other eResearch frameworks and institutional platforms, including in scientific and other research data management. This is in line with the international push towards open access, as journals and university repositories increasingly require deposit of research data that supports a thesis or publication.

Depending on the form such data are in, they may require emulation going forward.

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Author Biography

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