The digital preservation technological context

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Session overview

- Introductory comments
- Technical issues
- Preservation strategies
- Preservation metadata and shared infrastructure

Introductory comments

Digital preservation (1)

- Concerns continued access (and use)
- Digital preservation is NOT just about technology
- Unites a range of interrelated issues:
  - "... the planning, resource allocation, and application of preservation methods and technologies to ensure that digital information of continuing value remains accessible and usable" - Margaret Hedstrom (1998)

Digital preservation (2)

- Is sometimes now characterised as 'digital stewardship' or 'digital curation'
  - The concept of data curation originated in data-rich scientific domains like bioinformatics
  - Curation - "The activity of managing and promoting the use of data from its point of creation, to ensure it is fit for contemporary purpose, and available for discovery and reuse" - Philip Lord, *et al*. (2004)
  - "Maintaining and adding value to a trusted body of information for current and future use" -- DCC presentation at CNI (2005)

The fragility of digital content

The main technical issues

General comments

- Digital information is dependent on its technical environment
- Physical objects are subject to:
  - Physical deterioration
  - Technology obsolescence
- Relatively short timescales

Storage media (1)

- A major focus of concern in the 1970s and 1980s
- Current media types
  - Typically, magnetic or optical tape and disks, various devices (e.g., memory sticks)
  - Examples include: CD-ROM, DVD (optical), DAT, DLT (magnetic)
- Unknown lifetimes
  - Subject to differences in quality or storage conditions
  - But relatively short lifetimes compared to paper or good quality microform

Storage media (2)

- Technical solutions:
  - Periodic copying of data bits on to new media or types of media (refreshing)
  - Longer lasting media
  - Migrating to good-quality microform or paper (!)
- In an organised preservation system, regular routines (quality checking, backup, replication, refreshing, etc.) will help solve the media longevity issue

Technology obsolescence (1)

- A set of much bigger problems
- Software dependence
  - Digital content is, at least in part, dependent on the configurations of hardware and software (applications and operating systems) that were originally used to interpret or display them
- Hardware and software obsolescence
  - Application software and operating systems are upgraded regularly
  - Hardware becomes obsolete or needs repair

Technology obsolescence (2)

- Technical solutions
  - Various preservation strategies have been developed to cope with the obsolescence problem
  - For the most part, these depend on the existence of a continual programme of active management (life cycle management)
  - Supported by systems that implement the various functional entities identified by the Reference Model for an Open Archival Information System (OAIS)
  - Preservation strategies can only be seen in this wider context

Layers of meaning (1)

- Digital objects are logical entities not fixed to any one particular physical carrier
- Three layers (Thibodeau, 2002):
  - Physical objects: the actual bits stored on a particular medium
  - Logical objects: defines how these bits are used by application software, based on data types (e.g. ASCII); in order to understand (or preserve) the byte-streams, we need to know how to process them
  - Conceptual objects: what humans deal with in the real world, meaningful units of information

Layers of meaning (2)

- On which of these layers should preservation activities focus?
  - We need to preserve the ability to reproduce the objects, not just the bits
  - In fact, we could change the bits and logical representation and still reproduce an authentic conceptual object

Authenticity and integrity

- Digital information can easily be changed (e.g., by design or accident)
- How can we trust that an object is what it claims to be?
- Mechanisms are available at the bit level (e.g. checksums), but will this be sufficient?

Problems of scale

- An increasing flood of 'born-digital' data
  - Data deluge in science and engineering
    - » Petabytes generated by high throughput instruments, streamed from sensors and satellites, etc.
  - The World Wide Web
    - » Comprises billions of pages + "deep Web"
    - » Internet Archive = >1 petabyte, and growing @ 20 Tb. per month (http://www.archive.org/)
  - 5 exabytes of *new* information created in 2002:
    - » http://www.sims.berkeley.edu/research/projects/how-much-info-2003/

Some general principles (1)

- Most of the technical problems associated with long-term digital preservation can be solved if a life-cycle management approach is adopted
  - i.e. a continual programme of active management
  - Ideally, combines both managerial and technical processes, e.g., as in the OAIS Model
  - Many current systems (e.g. repository software) are attempting to support this approach
  - Preservation strategies need to be seen in this wider context
- Preservation needs to be considered at a very early stage in an object's life-cycle

Some general principles (2)

- Need to identify and understand the 'significant properties' of an object
  - Focuses on the essential
  - Helps with choosing an acceptable preservation strategy
- Encapsulation may have some benefits
  - Surrounding the digital object - at least conceptually - with all of the information needed to decode and understand it (including software)
  - Produces autonomous 'self-describing' objects, reduces external dependencies; linked to the Information Package concept in the OAIS Reference Model
- Keep the original byte-stream in any case

Digital preservation strategies

Preservation strategies

- Three main families:
  - Technology preservation
  - Technology emulation
  - Information migration
- Also:
  - Digital archaeology (rescue)

Technology preservation

- The preservation of an information object together with all of the hardware and software needed to interpret it
  - Successfully preserves the look, feel and behaviour of the whole system (at least while the hardware and software still functions)
  - May have a role for historically important hardware
  - Problems with storage and ongoing maintenance, missing documentation
  - Would inevitably lead to 'museums' of "ageing and incompatible computer hardware" -- Mary Feeney
  - May have a short-term role for supporting the rescue of digital objects (digital archaeology)

Technology emulation (1)

- Preserving the original bit-streams and application software; running this on emulator programs that mimic the behaviour of obsolete hardware
- Emulators change over time
  - Chaining, rehosting
  - Emulation Virtual Machines
    - » Running emulators on simplified 'virtual machines' that can be run on a range of different platforms
    - » Virtual machines are migrated so the original bit-streams do not have to be

Technology emulation (2)

- Benefits:
  - Technique already widely used, e.g. for emulating different hardware, computer games
  - Preserves the original bits
  - Reduces the need for regular object transformations (but emulators and virtual machines may themselves need to be migrated)
  - Retains 'look-and-feel'
  - May be the only approach possible where objects are complex or dependent on executable code
  - Less 'understanding' of formats is needed; little incremental cost in keeping additional formats

Technology emulation (3)

- Issues
  - Which organisations have the technical skills necessary to implement the strategy?
  - Preserving 'look and feel' may not be needed for all objects
  - It will be difficult to *know* definitively whether user experience has been accurately preserved
- Conclusions
  - Promising family of approaches
  - Needs further practical application and research

Information migration (1)

- Managed transformations
  - A set of organised tasks designed to achieve the periodic transfer of digital information from one hardware and software configuration to another, or from one generation of computer technology to a subsequent one - CPA/RLG report (1996)
  - Abandons attempts to keep old technology (or substitutes for it) working
  - A 'known' solution used by data archives and software vendors (e.g., a linear migration strategy is used by software vendors for some data types, e.g. Microsoft Office files)
  - Focuses on the *content* of objects

Information migration (2)

- Main types (from OAIS Model)
  - Refreshment
  - Replication
  - Repackaging
  - Transformation
- Issues
  - Labour intensive
  - There can be problems with ensuring the 'integrity and authenticity' of objects
  - Transformations need to be documented (part of the preservation metadata)

Information migration (3)

- Uses
  - Seems to be most suitable for dealing with large collections of similar objects
  - Migration can often be combined with some form of standardisation process, e.g., on ingest
    - ASCII
    - Bit-mapped-page images
    - Well-defined XML formats
  - Migration on Request (CAMiLEON project)
    - Keep original bits, migrate the rendering tools

Digital archaeology

- Not so much a preservation strategy, but the default situation if we fail to adopt one
- Using various techniques to recover digital content from obsolete or damaged physical objects (media, hardware, etc.)
  - A time consuming process, needs specialised equipment and (in most cases) adequate documentation
  - Considered to be expensive (and risky)
  - Remains an option for content deemed to be of value

Choosing a strategy (1)

- Preservation strategies are not in competition (different strategies will work together)
  - A suggestion that we should keep the original bits (with documentation) in any case
- But the strategy chosen has implications for:
  - The technical infrastructure required (and metadata)
  - Collection management priorities
  - Rights management
    - e.g, Owning the rights to re-engineer software
  - Costs

Choosing a strategy (2)

- Tools for supporting preservation decisions, e.g.
  - Preservation strategies
  - Target formats for transformations
- Nationaal Archief (Netherlands) testbed project
- Vienna University of Technology utility analysis tool
- Both developed further by the Digital Preservation cluster of the DELOS Network of Excellence

Case study

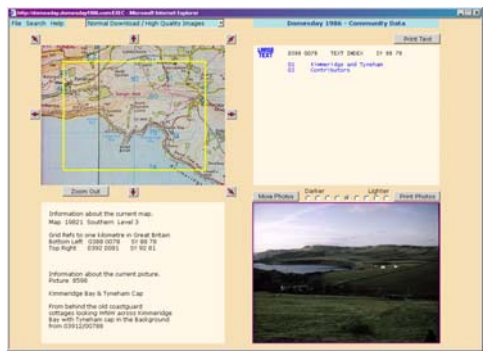
Rescue of content from BBC Domesday videodiscs

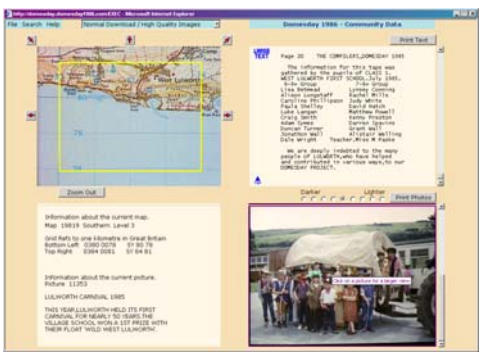
Rescue of BBC Domesday (1)

- BBC Domesday project (1986)
  - To commemorate the 900th Anniversary of the original Domesday survey
  - Two interactive videodiscs (12")
    - Mixture of textual material (some produced by schools), maps, statistical data, images and video
  - Technical basis:
    - Hardware: BBC Master Series microcomputer and Philips Laservision (LV-ROM) player
    - Some software in ROM chip, others on the discs
    - System obsolete by end of 1990s; working hardware becoming more difficult to find

Rescue of BBC Domesday (2)

- CAMiLEON project
  - Proof of concept for the emulation approach
  - Converted data into media-neutral form
  - Adapted an existing emulator for the BBC microcomputer to render Domesday content
- The National Archives (and partners)
  - Reengineered the whole system for use on Windows PCs
  - Digital versions of images and video converted from original master tapes (still held by BBC)
  - Developed an improved interface
  - Web version: http://domesday1986.com/





Preservation metadata and shared infrastructures

Preservation metadata (1)

- All digital preservation strategies depend - to a greater or lesser extent - on the creation, capture and maintenance of metadata
  - Preservation metadata:
    - The "information a repository uses to support the digital preservation process," specifically "the functions of maintaining viability, renderability, understandability, authenticity, and identity in a preservation context" (PREMIS Data Dictionary, 2005)
    - Cuts across older categorisations of metadata (descriptive, administrative, structural)

Preservation metadata (2)

- PREMIS Working Group
  - Preservation Metadata: Implementation Strategies
  - Working Group sponsored by OCLC and RLG
  - Reviewed earlier Metadata Framework document and existing practice
  - Focused on implementation and definition of 'core' metadata
  - PREMIS Data Dictionary (May 2005)

Preservation metadata (3)

- PREMIS Data Dictionary
  - Less explicitly based on OAIS Information Model structure than older OCLC/RLG Framework
  - Based on own data model
  - Defines some of the semantic units for: Objects, Events, Agents, Rights
  - Supports automatic capture, where possible
- PREMIS also provides:
  - An XML implementation, e.g. for use in a packaging format like METS (Metadata Encoding and Transmission Standard)
  - Maintenance activity (Library of Congress)

Shared infrastructures

- For example: registries for sharing information about, or for identifying or validating formats, etc.
  - There is "… a pressing need to establish reliable, sustained repositories of file format specifications, documentation, and related software" (Lawrence, *et al*., 2000)
  - DSpace 'bitstream format registry'
  - Global Digital Format Registry (GDFR)
    - » Some components exist, e.g. Typed Object Model, JHOVE tool
  - DCC Representation Information registry

Some final comments

- The technical issues of digital preservation are only one part of a multidimensional problem
- Progress has been made on addressing technical problems
- Need for sustainability and co-operation
- Need for people with the appropriate skills

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