Aerospace Industry Requirements for a Long Term Data Retention Process

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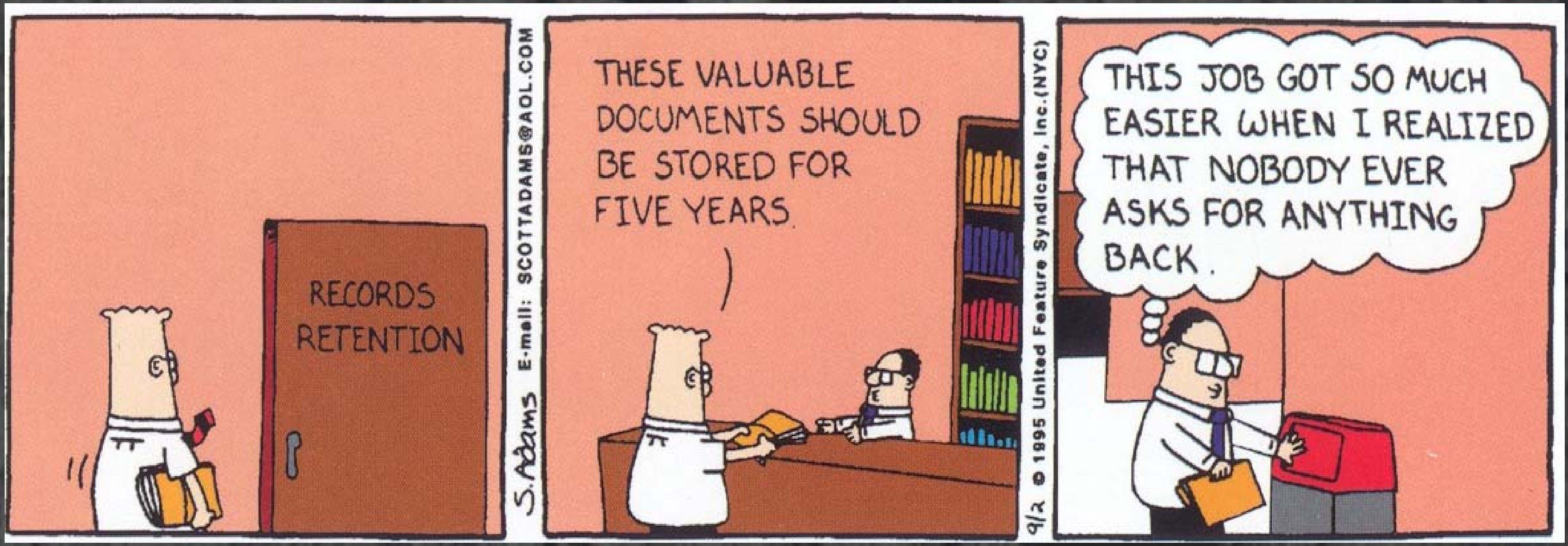
The Simple Solution

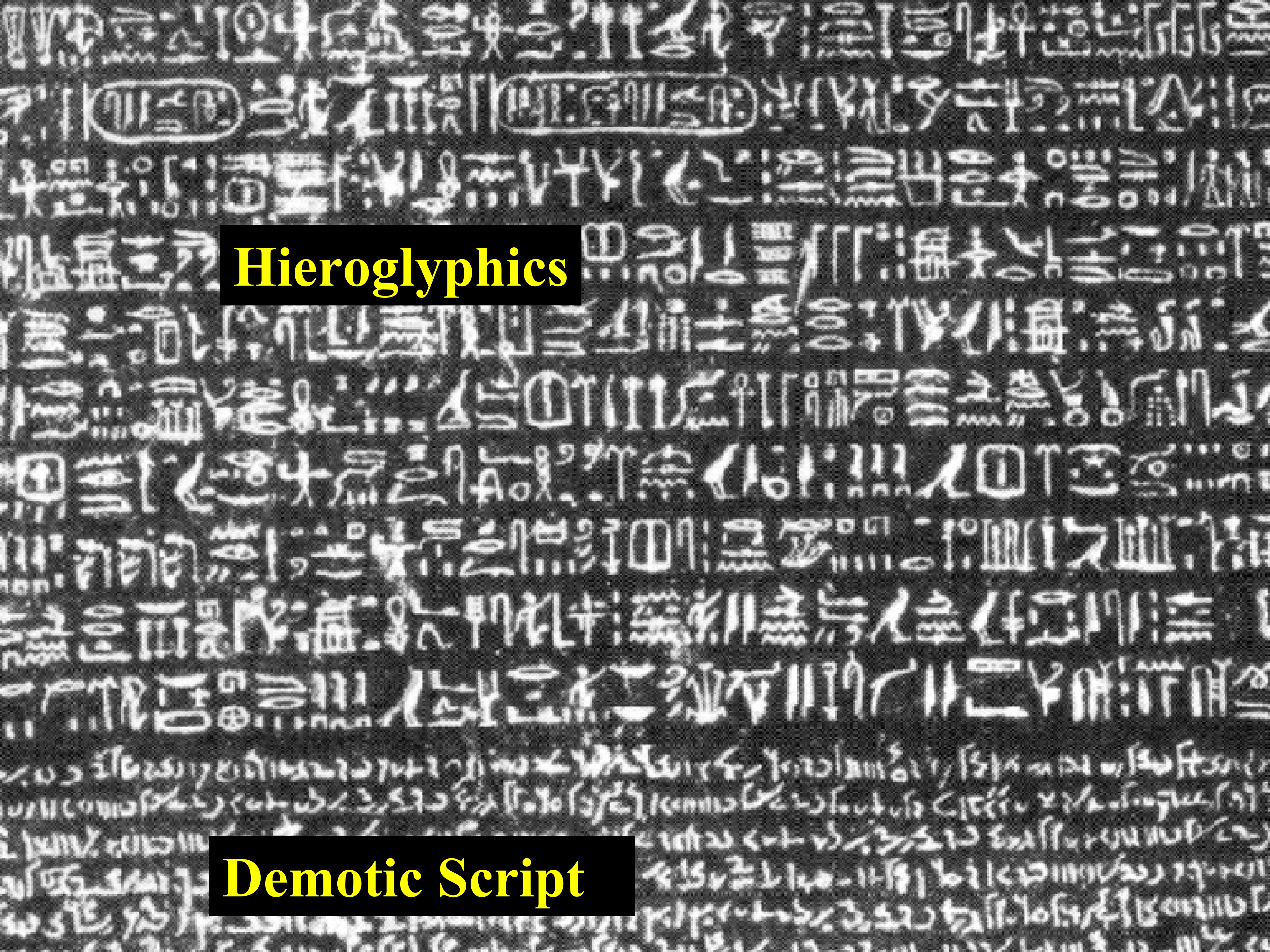


Agenda

- **Data Longevity**
  - Why We Care
  - What the Requirements Are
- **Aerospace Industries Association Activity**
  - Aerospace Recommended Practice ARP9034
- **International Aerospace Quality Group Project**

Before Computers…

- Data longevity based on material durability
- Data access via eyeball
- Interpretation via brain
- But…
  - Technology still evolved
  - Data longevity was not ensured


Hieroglyphics
Demotic Script


Greek

The Rosetta Stone

- Egyptian hieroglyphics in use for 3500 years
- Written language migrated to new technology (script based on Greek alphabet)
- The ability to to understand hieroglyphics was lost for 1400 years
- Rosetta Stone uncovered in 1799. It took 14 years to understand and interpret this “key”

Fast Forward to present

- Data is critical business asset
- Computing systems required to interpret data
- Computing systems, applications, media, hardware all evolve constantly (lifecycles <10 years)
- Many companies implementing 3-D based digital design processes (no drawings or paper documents)
- Retaining product data for multiple decades is a very complex problem

Definitions from Civil Aviation

- FAA: Federal Aviation Administration
- Type Certificate - Piece of paper that says the FAA approves an airplane design.
- Type Design Data - The product design data approved by the FAA under the Type Certificate.

Why We Care

- It is an Federal Aviation Requirement to maintain the capability to retrieve type design data in a usable form for the life of the Type Certificate.
  - Code of Federal Regulation (CFR) 21.49, CFR 21.41, and CFR 21.31

Why We Care

- Design data is required to support the product over its entire life cycle.
  - Changes to product
  - Customer support
  - Modification business for certain types of products
  - Design re-use: avoid “re-inventing the wheel”
  - Assist in investigating causes of in-service problems.
  - Avoid potential litigation costs associated with being unable to retrieve and use design data.

Technology Lifecycles

- At least three technology life cycles need to be considered:
  - Product: The products defined by the design data. (50+ years)
  - Storage: The technologies used to permanently store and retrieve the digital data. (~10 years)
  - Applications: The technologies used to interpret the digital data. (~3 years)
  - Note: The computing environments (hardware platforms and operating systems) are included as part of the technologies addressed for storage and applications.

Aerospace Industries Association (AIA) Working Group on the Longevity of Digital Type Design Data

- Initiated by Boeing at the request of the FAA

AIA Working Group History

- Initial meeting August 8-10, 2000 Washington DC.
  - Boeing
  - Cessna
  - Gulfstream
  - Raytheon Aircraft
  - Lycoming Textron
  - GAMA
- Quarterly working group meetings from 8/2000 to July 2002

AIA Sub-team Structure

Civil Aviation Council
Mfg. Maint. & Repair Committee

CHAIRMEN
Peter Gallimore
Rick Zuray

BOEING
Jeff Klein
David Briggs
Bill Black
Babak Hamidzadeh

VOUGHT
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Working
Participants
Team

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Jim Reid

Pratt & Whitney
Bill Marler

Gulfstream
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Team Mission

- Identify, document and publish an industry consensus standard that defines requirements for a process to ensure that three dimensional type design data stored in digital format, is retrievable and usable in accordance with Regulatory requirements for the life of a type certificate. This process must address business and legal considerations.

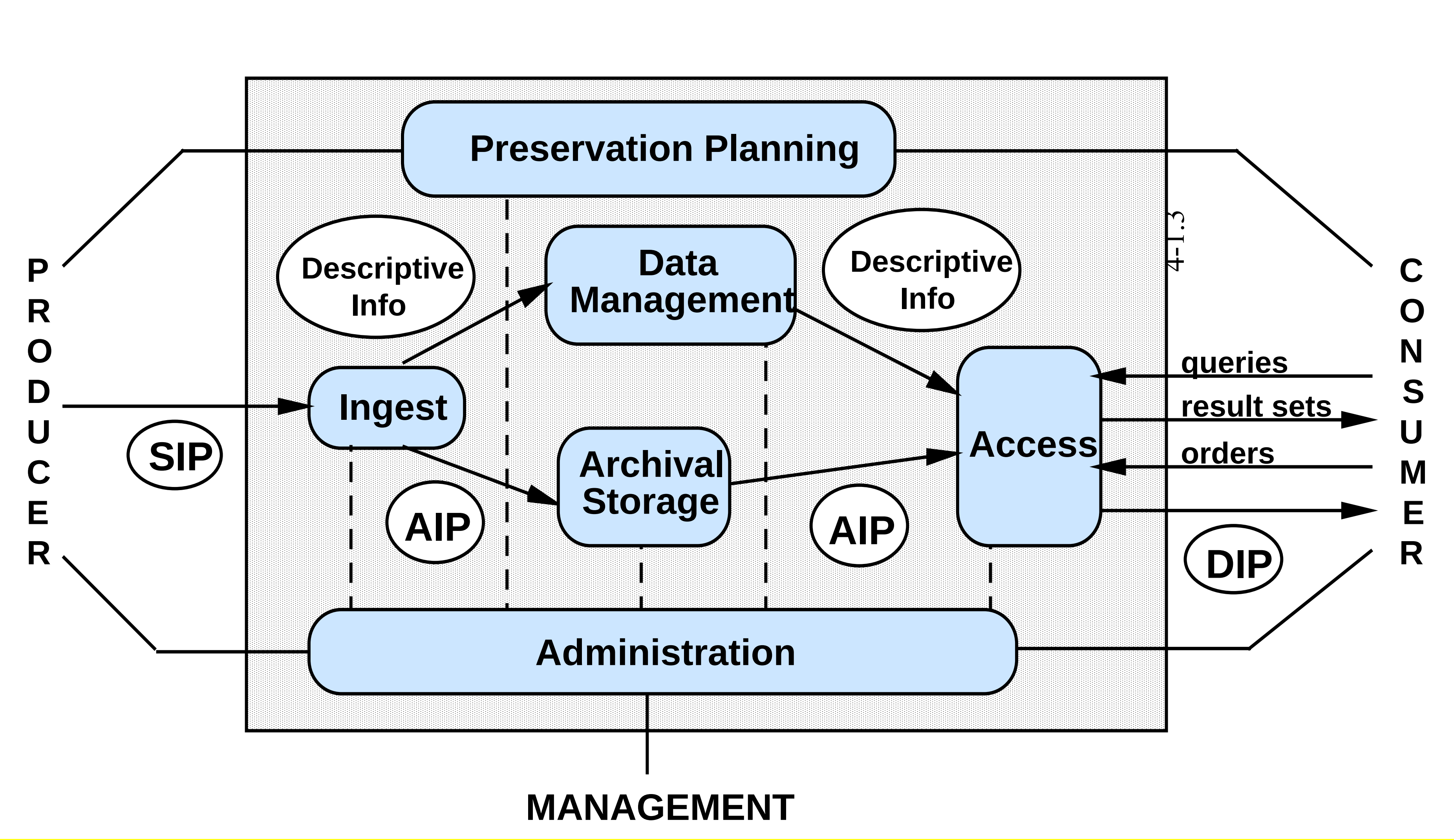
Team Results

- Held multiple working together meetings
- First few meetings spent level setting, reviewing existing standards, technologies and activities across the industry
- Developed requirements for retention process
- Completed developing content for the process standard.
- Document completed November 2002

Working Group Accomplishments

- The consensus of the team is that a performance standard is the approach to use for this project.
- The consensus of the team is that Open Archive Information System (OAIS) reference model is the best framework for the development of the process standard.
- Developed set of requirements.
- Incorporated and expanded on requirements in draft process document, incorporated requirements into the OAIS framework.

OAIS Reference Model



Categories of Requirements

- Data Integrity
- Data Security
- Configuration management
- System Architecture
- Data Content
- And others

Status of document

- Approved by Society of Automotive Engineers (SAE) and American Aerospace Quality Group (AAQG) as Aerospace Recommended Practice ARP9034
- Started harmonization with European AECMA-STAN Long Term Archiving (LOTAR) project
- Will be proposed to International Aerospace Quality Group as AS9134
- That's where you come in…

Feedback from SAE/AAQG Review

- Current document is focused on civil aviation industry
- We need review and concurrence from defense and space sectors
  - Government agencies
  - Contractors
  - Supplier base
  - PLM Software suppliers

…to review the requirements document. Are the requirements appropriate for your industry?

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Recommended Reading

- Open Archive Information System (OAIS) model, http://ssdoo.gsfc.nasa.gov/nost/isoas/ref_model.html
- "The Commission on Preservation and Access's Annual Report", 1992-1993.
- "Avoiding Technological Quicksand: Finding a Viable Technical Foundation for Digital Preservation", by Jeff Rothenberg; January 1999; A Report to the Council on Library and Information Resources.
- "Preserving Digital Information", by Gregory S. Hunter


Questions?

Back-up Slides

Data Longevity Options

WHY?

- FAA Compliance: Type design data must be retrievable and usable (viewable) for the life of the program (50+ years).
- Ensure "reusability" of design data. Protect the investment we've made.
- Reduce costs associated with investigations by ensuring design data is readily available.

2D Product Definition (on stable hard-copy)

Require that an accurate 2D representation be created for each 3D model. (Research lower cost material?)

PRO's
- Proven technology

CON's
- Expensive
- Few other users within industry.
- Drawings would have to be recreated in latest application format to re-use the design.

Incremental Dataset Migration.

Migrate all datasets to latest format.

PRO's
- Eliminates the need to maintain applications ability to read older formats.
- Datasets always available for re-use in current application.

CON's
- Expensive to migrate and validate large amounts of datasets.

Backwards Compatible Solutions

Require that latest versions of applications are able to use older dataset formats, or develop "viewer(s)" for older formats.

PRO's
- Dataset available to any compliant application (in theory).
- Ensures the ability to "view" a dataset.

CON's
- Re-use is not necessarily guaranteed. Older formats may not be compatible with newer applications, so only viewing may be possible.

Neutral dataset format: STEP, IGES, ...

Datasets saved in neutral format are usable in any compliant application (in theory).

PRO's
- Eliminates the need to maintain application's ability to read older formats (in theory).

CON's
- Marginal success with early formats.
- Evolving standards mean there is risk that older "neutral" formats won't be compatible with newer applications, so would still need to ensure backwards compatibility.

Other Strategies: Encapsulation and Emulation

Encapsulation: Dataset is saved as a package that includes the capability to view the dataset in human readable form.

Emulation: The hardware platform needed to execute an application required to view a dataset is emulated on current platforms.

PRO's
- The quantity of legacy datasets becomes irrelevant.

CON's
- Theory only at this point.


Who Else Is Working on This?

Who Else Is Working on This

- Most of the activity centers around libraries, archives, and related professions.
- The approaches are still in development and much of the required technology isn't available for the two primary approaches.
  - Emulation
  - Encapsulation

Who Else Is Working on This

- What's Emulation?
  - Emulation: Develop software that emulates a hardware and/or operating system environment so that the original application can be used to access the data.
    - Of course, this requires that the application be retained.

Who Else Is Working on This

- What’s Encapsulation?
  - In a repository, store all software required to access data in a digital “package”.
  - What’s “required” will change over time based on existing technology and the capabilities of the community that uses the data, so encapsulated data will need to be updated over time.

Who Else Is Working on This

- ISO TC20/SC13 Consultative Committee for Space Data Systems developed an Open Archive Information System (OAIS) model. (NASA is Secretariat).
- ISO and others have developed platform independent data formats (e.g. STEP) primarily geared towards data exchange, but may also be useful for long term preservation.

Terms and Concepts From Other Groups

Features of Digital Integrity*

- **Content** – The knowledge or ideas that the digital object contains. Data Owner is responsible for defining, validating, and verifying the content.
- **Fixity** – In order to have integrity, the content of a digital object must be protected from change. Conversely, any unauthorized changes must be detectable (e.g. encryption, cyclic redundancy codes, etc.).
- **Reference** – Must be able to locate a digital object definitively and reliably among other digital objects over time. Standard systems of reference need to be used and carried forward over time.
- **Provenance** – Establish and maintain a record of the origin and chain of custody of the digital object (i.e. a change history). This helps to establish the authenticity of the digital object.
- **Context** – The ways in which a digital object interacts with (depends on) elements in the wider digital environment. This includes a technical dimension (hardware and software dependencies); a dimension of linkage to other objects (e.g. hyperlinks, parametrics); a communications dimension (e.g. distribution on a network via e-mail, web, ftp, etc.); and a wider social dimension (i.e. political and organizational considerations).

* paraphrased from “Preserving Digital Information”, by Gregory S. Hunter.