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You Do Not Know Until It is Not Useable: Metadata and Paradata Management for Photogrammetry Preservation and Archiving

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Abstract

Photogrammetry has greatly improved the recording, preservation, and accessibility of cultural heritage in archaeology and scientific research. The increased use of 3D modeling in heritage projects brings about significant challenges, especially in terms of data management. In this context, the challenges involve ensuring that digital models are reliable, traceable, and usable. Often, these concerns are disregarded until they impede access or reuse, affecting the long-term preservation and accessibility of cultural heritage data.

Keywords: paradata, data management, data reuse, research data management, metadata, 3D modeling, photogrammetry, cultural heritage preservation

1. Introduction

Photogrammetry has become an essential asset in archaeology, scientific research, and the safeguarding of cultural heritage. It facilitates the development of complex 3D reconstructions that exceed the constraints of conventional 2D digitization. The 3D models present considerable opportunities for documentation and analysis; nonetheless, their lasting value depends on factors that go beyond mere technical accuracy. Managing metadata and paradata is crucial for ensuring that photogrammetric results are reliable, understandable, and reproducible.

Ensuring the reliability, understandability, and repeatability of photogrammetric outputs hinges on meticulous management of metadata and paradata, aspects frequently neglected in the rush to complete 3D products. Metadata organizes digital assets with standardized descriptions for easy access across different platforms. Paradata, following the London Charter (2009), documents the reasoning and decision-making behind 3D model creation, fostering transparency in scholarly endeavors **[1]**.

Overlooking paradata presents a notable challenge to preserving the archival integrity of photogrammetric datasets. Neglecting it undermines the long-term integrity and scholarly utility of photogrammetric datasets—a concern underscored in digital heritage literature, where comprehensive documentation is often secondary to rapid digitization **[2]** **[3]**.

2. The Role of Metadata and Paradata in Photogrammetry

2.2 Metadata: Structuring Digital Assets

Metadata organizes digital assets with standardized descriptions to make them easier to find and use across various platforms. Technical metadata includes key specifications such as spatial resolution, coordinate systems, and file formats, which are crucial for ensuring compatibility across different software platforms. Descriptive metadata offers crucial contextual insights about the subject, covering its historical importance, cultural origins, and creator details, thereby improving discoverability across diverse disciplines. Administrative metadata, encompassing rights management and preservation histories, plays a vital role in ensuring long-term stewardship by meticulously overseeing ownership, access rights, and conservation efforts.

2.3 Paradata; Documenting the Invisible Workflow

Unlike metadata, which describes the characteristics of a digital object, paradata captures the intellectual and procedural rationale behind 3D model creation, such as lighting conditions and software configurations, crucial in modern paradata practices. Paradata offers valuable insights into photogrammetric model creation by documenting the tools, methods, and decisions involved. Dallas criticizes the idea of static digital artifacts and promotes layered documentation, emphasizing that digital objects need contextual layers to maintain their scholarly significance and establishes how paradata can be integrated into digital curation frameworks, particularly in archaeological and photogrammetric contexts, to preserve the rationale behind methodological choices **[2]**.

In legacy environments and archival contexts, the lack of paradata poses challenges for validating and reinterpreting 3D materials. Researchers, archivists, and curators may encounter difficulties in understanding or adapting a model when key elements of its development are missing: Was this object scanned in natural light or with studio lighting? Were textures manually edited or algorithmically processed? What version of the software was used, and were any updates applied during the project? These seemingly minor details become critically important when reusing a model in new research, evaluating its scientific accuracy, or reconstructing the methodology for educational or technical purposes.

Photogrammetry, like other forms of digital reconstruction, is susceptible to choices that shape the resulting 3D model—choices about lighting, texture fidelity, mesh simplification, and software tools. Bentkowska-Kafel and colleagues advocate for the explicit recording of these choices as “paradata,” emphasizing that such transparency is critical for future interpretation, replication, and scholarly critique **[3]**. They contend that because cultural, institutional, and technological frameworks shape digital representations, they are not neutral and require contextual documentation to make this process visible **[3]**. Without this information, models risk becoming “orphaned” assets—data-rich but context-poor and functionally opaque.

3. Operational Challenges in Managing Metadata and Paradata

In his work 'Challenging Heritage Visualisation: Beauty, Aura and Democratisation,' Jeffrey criticizes the tendency of heritage visualization to prioritize visual accuracy and aesthetic appeal over transparency, process visibility, and collaborative authorship **[4]**. This critique aligns with the concept of paradata, which refers to documentation capturing the technical, ethical, and methodological choices that influence the creation of a model **[4]**. Paradata contests the idea that a 3D visualization is enough to convey meaning, highlighting the importance of retaining context like software choices or ethical dilemmas in restoration. Jeffrey supports open, self-reflective practices that are in line with the goals of paradata for accountability and democratization of knowledge production **[4]**. However, implementing these ideas presents significant challenges.

A primary obstacle is the lack of universal standards for structuring paradata. Incomplete or inconsistent paradata often results from underfunding and lack of standardized workflows, as noted in studies of heritage digitization projects **[3]**. Institutions often use different frameworks like Dublin Core for basic information or detailed heritage documentation standards, leading to compatibility issues that hinder data sharing and future use. There is no universal standard for organizing or encoding paradata, resulting in varied practices across institutions **[3]**. These inconsistencies are compounded by technical and institutional hurdles. Outdated file formats, undocumented workflows, and inadequate museum infrastructure jeopardize the preservation of contextual data. For example, digitizing artifacts without proper server allocation or staff training for paradata management poses a risk. Undermining trust in the authenticity of 3D models. A 3D model in archives, without paradata, is akin to a manuscript lacking provenance or a photograph missing a date or location. Although a 3D model may seem comprehensive and visually appealing, its scientific value is significantly reduced in terms of verifying authenticity, understanding methodology, or replicating findings.

In archival contexts, the lack of paradata diminishes the academic worth of a model. A 3D asset without context resembles an undated photograph or a manuscript stripped of provenance: visually compelling but methodologically opaque. Archivists encounter challenges in managing vast collections as documenting numerous paradata fields per model becomes unfeasible. As original project teams disband and technologies age, ongoing discussions focus on defining 'sufficient' documentation. This includes deciding whether to preserve all model changes or only the final workflows, highlighting the balance between accuracy and usefulness.

Bormann emphasizes the importance of investing in common standards, proactive technical strategies, and collaborative governance to safeguard digital artifacts from becoming inaccessible or lacking meaning **[5]**. But cross-disciplinary and international collaborations encounter challenges in harmonizing diverse documentation methods **[6]**. Additionally, funding organizations frequently rank paradata management as a low-priority issue. These challenges compound over time: as project teams disband, technologies fall into obsolescence, and the contextual assumptions behind documentation erode and the role of paradata grows increasingly critical. Amico and Felicetti highlight how legacy file formats and undocumented workflows jeopardize 3D heritage preservation, emphasizing the need for paradata to mitigate risks of data loss **[7]**. Without extensive details and updated file formats, future scholars may lose the capacity to verify, reinterpret, or ethically engage with digital heritage.

4. Integrated Approach to Paradata Management

Implementing effective documentation strategies is crucial for maintaining the accessibility, interpretability, and actionability of paradata and metadata. This ensures their enduring value amidst technological advancements and organizational transitions. The Digitization Center at the American University in Cairo, in collaboration with its Records Management team, has devised workflows that underscore the significance of metadata and paradata in the preservation of photogrammetry. These workflows focus on recording technical specifications, software configurations, and environmental variables during capture. This collaboration has led to the creation of a standardized Project Documentation Packet, designed to meet the requirements of cultural heritage initiatives. The document comprises sections on object provenance, cultural context, and licensing agreements, alongside dedicated areas for paradata, which encompass recording settings, sensor configurations, and environmental variables at the time of capture.

4.1 Context Preservation through Project Documentation Packet

A Photogrammetry Project Documentation Packet functions as a standardized, user-friendly toolkit designed to support the creation and management of paradata, particularly for users unfamiliar with technical formats like XML or CIDOC-CRM. It bridges the gap between complex preservation frameworks and practical daily workflows, enabling effective documentation even for those without specialized technical expertise. Available in both print and digital formats, the packet consists of structured templates and instructional guides for recording technical specifications, software configurations, and post-processing decisions.

Importantly, the packet includes dedicated sections where users can document interpretative choices made during model capture or editing, with prompts written in accessible language that minimizes jargon. This feature makes it easier for team members with limited experience in digital preservation to contribute meaningful paradata. Visual workflows map out each stage of the photogrammetry process—from image acquisition to final 3D export—helping users clearly associate documentation with each procedural step. To enhance usability, digital versions of the packet include QR codes that link to video tutorials, sample entries, and glossaries. This system not only encourages consistency and transparency but also supports training and knowledge retention across collaborative and rotating staff environments. Ultimately, the packet shows how careful design and clear instructions can make it easier for everyone to participate in documenting paradata. Refer to Appendix A for an example of a completed Project Documentation Packet.

4.2 Alternative Context: Preservation via XML, or Extensible Markup Language

XML, or Extensible Markup Language, offers an effective and structured method for documenting the intricate steps, tools, and decisions associated with the development of digital projects such as 3D models, ensuring comprehensive documentation for future reference. Consider it a digital notebook that captures not only the outcome but also the complete process of creation. When producing a 3D scan of a historical artifact, XML can effectively document the camera settings utilized, software versions, lighting conditions, and notes regarding the exclusion of specific fragments. This organized format ensures clarity and consistency, facilitating understanding of the process even years down the line. XML's use of straightforward labels and categories maintains human readability while facilitating seamless interaction with computers, thereby ensuring data can be shared, preserved, and adapted as technology progresses. Refer to Appendix B: Sample XML documentation for a historical artifact 3D scan.

4.3 Alternative Context: Linking CIDOC-CRM with Paradata

The International Council of Museums (ICOM) developed CIDOC-CRM as an ontology to standardize the integration and exchange of cultural heritage data. It provides a structured approach to defining entities like objects, people, and events, as well as their relationships, enhancing interoperability across different systems and institutions. It offers a practical approach for establishing a semantic framework to document the relationships between cultural heritage objects, the individuals and institutions involved, the changes they experience, and the associated documentation practices. CIDOC-CRM converts paradata from unstructured notes into a linked, queryable knowledge graph. Embedding photogrammetry workflows into this framework allows institutions to maintain transparency, reusability, and trustworthiness of 3D models for decades. This integration connects the technical advancement of 3D models with their enduring cultural and academic significance. Refer to Appendix C: Integration of CIDOC-CRM with paradata for enhanced documentation.

5. Strategies for Effective Metadata and Paradata Management

Implementing effective metadata and paradata management strategies necessitates addressing technical workflows alongside institutional culture considerations. Research indicates that structured training programs play a crucial role in diminishing documentation errors within digitization workflows, improving metadata and paradata management practices. The training modules in the PARTHENOS Project focus on ensuring version control and transparency in 3D modeling by providing guidance on tracking changes and maintaining documentation standards and assisting heritage professionals in adhering to these practices.

The difficulty in standardization involves resolving conflicts between adaptable schemas like PREMIS and specialized standards like CIDOC-CRM. While flexible schemas like PREMIS (Preservation Metadata: Implementation Strategies) harmonize paradata across projects, their implementation often requires reconciling conflicts with discipline-specific standards such as CIDOC-CRM. Automation tools, such as Python scripts, simplify the process of recording technical parameters like sensor data and timestamps by automatically capturing and organizing this information. However, qualitative decisions, such as ethical choices in digital restoration, still need manual input, which can lead to gaps when time is limited **[2]**.

Interdisciplinary teams, as highlighted by collaborative frameworks like those advocated by McKenzie **[6]**, play a crucial role in reducing documentation gaps. For instance, involving archivists in digitization processes has proven to enhance the uniformity of metadata and the planning for long-term preservation **[8]**. The EU-funded 4CH project advances transnational collaboration and interoperable frameworks for cultural heritage data, prioritizing goals consistent with FAIR principles—such as reusability and transparency—in its approach to 3D preservation **[9]**. This initiative, supported by the Horizon Europe program with a total budget of €3 million, aims to enhance collaborative frameworks for digital preservation by bringing together 16 partner institutions, including research centers, universities, and heritage organizations, to work towards this common goal **[9]** **[10]**. By prioritizing interoperability and transparency in workflows, the project underscores the strategic value of paradata in sustaining the accessibility and authenticity of digital heritage.

In the end, paradata is more influential when it harmonizes with institutional goals in managing metadata and paradata, guaranteeing thorough and efficient data stewardship. According to ONEIL, there is a shared emphasis on the institutional advantages stemming from thorough documentation, including enhanced collaboration, increased accountability, and improved data integrity, leading to more effective research outcomes and knowledge dissemination **[11]**.

6. Conclusion

Given photogrammetry's growing role in cultural heritage preservation, addressing documentation gaps must be treated as a strategic imperative. Explaining the critical role of metadata and paradata as fundamental components, rather than mere additions, not only enhances the credibility of digital content like 3D model reproducibility but also empowers researchers to engage with, reinterpret, and expand upon existing records for continuous scholarly investigation. Metadata and paradata guidelines ensure the effective understanding, authentication, and reuse of 3D datasets by providing structured information about the data's origin, creation process, and context. Incorporating metadata and paradata guidelines into digitization processes helps uphold technical precision by ensuring accurate data representation and considers interpretive aspects of heritage work, such as making informed ethical restoration choices.

Preserving photogrammetric models in the long run relies not just on metadata and paradata solutions but also on continuous training to interpret and record contextual information accurately. Research shows that organized documentation can be enhanced by institutions dedicating resources to activities like teamwork, automation, and staff training. Providing training on documentation methods transforms 3D models from static representations to interactive, well-documented tools that can preserve knowledge for future generations. Through meticulous recording of decisions like sensor settings or texture preferences, institutions preserve the reasoning and history of digital objects, enhancing their utility for research and adaptability in diverse scenarios.

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Author Biography

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Elizabeth H. Day is the Assistant University Archivist for Records Management at The American University in Cairo, focusing on the framework of the university’s physical and digital records and supporting the Rare Books and Special Collections Library’s University Records collection. Obtaining a BA in International Affairs and Religious Studies, Day then received her Master's in Archival Studies from the University of British Columbia, focusing on integrated record systems, government and public records, and archival ethics.

Appendix A:

Example 1: Structure of the Photogrammetry Project Documentation Packet

1. Pre-Capture Setup Sheet—Baseline conditions and project intentions.	
Fields:	• Project ID and object description • Photographer(s) and technician(s) • Equipment list (camera make/model, lens, tripod, calibration tools) • Lighting setup diagram (with positioning, type, and power settings) • Calibration method and reference chart used • Environmental conditions (indoor/outdoor, time of day, ambient light) • Intended output format and resolution goals
2. Capture Session Log—Technical data and decision-making during image acquisition.	
Fields:	• Image file naming conventions and structure • Total number of images captured • Camera settings: ISO, aperture, shutter speed, focal length • Notes on changes made during session (e.g., tripod height, angle adjustments) • Observations: shadows, reflections, surface detail challenges
3. Processing Journal—Step-by-step transformations from image to 3D model.	
Fields:	• Software name and version number • Workflow steps (alignment, sparse cloud, dense cloud, mesh, texture) • Quality thresholds and filtering parameters • Manual edits (masking, trimming, hole filling) • Visual notes or screenshots for complex decisions • Export settings and file formats generated
4. Revision and Migration Log—Long-term traceability and interoperability.	
Fields:	• Post-project updates: file format migrations, resolution adjustments • Metadata schema changes • Date and description of archival refresh or digital repository upload • Linked identifier to repository record or DOI
5. Paradata Reflection Sheet—Interpretive insight into methodology and intent.	
Fields:	• Why certain tools or techniques were chosen • Deviations from standard procedure and justifications • Lessons learned or recommendations for future models • Collaborator comments (archivists, curators, subject experts)

Example 2: Structure of the Photogrammetry Project Documentation Packet

1. Project Basics	
	• Name: Give your project a clear title (e.g., "Forest Reserve 3D Mapping"). • Who's involved: List team members and their roles (e.g., "Alex: Drone Pilot"). • Where & When: Location (GPS coordinates or address) and dates. • Goal: Why are you doing this? (e.g., "Create a 3D map to track erosion").
2. What You Created	
	• 3D models (like a digital twin of a building). • Maps (orthomosaic images that look like satellite maps). • Measurements (e.g., volume of a stockpile).
3. How You Did It	
	• Tools Used: Drone/camera model (e.g., "DJI Phantom 4"). • Settings: Flight height, photo overlap (e.g., "80% overlap"). • Challenges: Note issues (e.g., "Windy weather caused blurry photos").
	• Software: Name the tools (e.g., "Pix4D" or "Agisoft"). • Steps:

	○ Align photos. ○ Add ground markers (GCPs) for accuracy. ○ Build 3D model/textured map.
4.Quality Checks	
Accuracy:	• Compare measurements to real-world checks (e.g., "Model error: ±2 cm"). • List mistakes and how you fixed them (e.g., "Re-flew area with better lighting").
5. Files Handing Over	
Include:	• 3D model files (e.g., .OBJ, .LAS). • Maps (GeoTIFF, PDF). • A simple report (1–2 pages summarizing results).
6. Team & Timeline	
Include:	• Who did what: "Sam processed data; Rita managed flights." • Schedule: Key dates (e.g., "Flights: March 5; Final model: March 12").
7. Permissions & Rules	
Include:	• Did you get permits to fly the drone? • Did you blur private areas (e.g., faces, license plates)?
8. Sign-Off	
Include:	• Client approval: A section for them to sign/date. • Team sign-off: Internal confirmation everything's done.

Appendix B: Paradata Components in the XML Log

1. A simplified hypothetical XML structure illustrating the key paradata elements:

```
<photogrammetry_process_log>
  <project_id>AUC_CERAMICS_2020</project_id>
  <capture_environment>
    <ambient_light>6500K (daylight balanced)</ambient_light>
    <lens_calibration>
      <focal_length>50mm</focal_length>
      <aperture>f/8</aperture>
      <sensor_size>Full-frame</sensor_size>
    </lens_calibration>
  </capture_environment>
  <processing_choices>
    <software>Agisoft Metashape v1.7</software>
    <alignment_accuracy>High</alignment_accuracy>
    <mesh_decimation>30% (due to hardware limitations)</mesh_decimation>
  </processing_choices>
  <ethical_decisions>
    <excluded_fragments>
      <fragment_id>CER-045B</fragment_id>
      <reason>Uncertain provenance; potential modern replica</reason>
    </excluded_fragments>
  </ethical_decisions>
</photogrammetry_process_log>
```

2. Key Elements Explained

1. Ambient Light Levels:
   a. Documented as 6500K (daylight balanced).
      i. Lighting affects texture and color accuracy in the 3D model. Future researchers can replicate conditions or adjust for discrepancies.
2. Lens Calibration Metrics:
   a. Focal length, aperture, and sensor size were recorded.
      i. Ensures geometric accuracy. If lens distortion occurs, these details allow reprocessing with correction profiles.
3. Ethical Exclusion of Fragments:
   a. Fragment CER-045B was excluded due to uncertain provenance.
      i. Prevents misinterpretation of the dataset's cultural context. Future researchers won't assume the fragment was part of the original artifact.
4. Mesh Decimation (30%):
   a. The mesh (3D structure) was simplified to 30% of its original resolution.
      i. Computational constraints in 2025 limited processing power. By 2028, researchers could reanalyze the raw photos with modern hardware, avoiding outdated compromises.

3. Linked Preservation Repository
The XML log can be stored in a digital repository alongside the 3D model, connected via persistent identifiers (e.g., a DOI or ARK).

Visual Workflow:
```
[3D Model File] ⟷ [Metadata Record]
                         ↑
[XML Process Log] ⟷ [Ethical Guidelines]
```

- *Linkage*: The log is cross-referenced with the model's metadata and institutional ethical policies, ensuring full contextual traceability.

Appendix C: CIDOC-CRM Hypothetical Concepts for Paradata Mapping

Documentation Section	CIDOC-CRM Class	Description
Pre-Capture Setup	E7 Activity E29 Design or Procedure E39 Actor	The planned photogrammetry session as an event with defined procedures and goals.
Image Acquisition	E9 Move E13 Attribute Assignment	Moving the equipment, setting attributes like lighting or exposure.
Capture Session Log	E7 Activity E16 Measurement	Details about measurements and settings—each a discrete action.
Software Processing Steps	E7 Activity E11 Modification E39 Actor E14 Condition Assessment	Software-based actions and decisions with human actors logged as participants.
Tool and Software Use	E24 Physical Man-Made Thing E29 Design or Procedure	Specific hardware or software invoked during the modeling process.
Paradata Reflection Sheet	E13 Attribute Assignment E73 Information Object E65 Creation	Reflective interpretation or rationale tied to a model creation instance.

The procedure illustrates components from the table.

1. Pre-Capture Setup

- **E7 Activity**: Represents the planning phase of the photogrammetry session (e.g., "3D Digitization of Artifact X").
- **E29 Design or Procedure**: The documented methodology (e.g., "Use 80% image overlap, ISO 100").
- **E39 Actor**: The team or software responsible (e.g., "AUC Digitization Team").
  Visual Mapping:
```
[E7 Activity: "Pre-Capture Planning"]
├── P2 has type → [E29 Design/Procedure: "Photogrammetry Protocol v2.1"]
└── P14 carried out by → [E39 Actor: "AUC Team"]
```

Example:
"The team planned a session using a 24MP DSLR, 80% overlap, and diffuse lighting (E29)."

2. Image Acquisition

- **E9 Move**: Physical actions (e.g., moving the camera around the artifact).
- **E13 Attribute Assignment**: Assigning properties (e.g., "f/8 aperture", "ISO 400").
  Visual Mapping:
```
[E9 Move: "Camera Positioning"]
├── P16 used specific object → [E24 Physical Man-Made Thing: "Canon EOS R5"]
└── P141 assigned → [E13 Attribute Assignment: "Ambient Light: 6500K"]
```

Example:
"Moving the tripod (E9) was logged alongside assigned exposure settings (E13)."

3. Capture Session Log

- **E7 Activity**: The overall capture session (e.g., "Session 1: Ceramic Vase").
- **E16 Measurement**: Quantifiable parameters (e.g., "Distance to object: 1.2m").
  Visual Mapping:
```
[E7 Activity: "Session 1"]
├── P40 observed dimension → [E16 Measurement: "Distance: 1.2m"]
└── P32 used general technique → [E55 Type: "Structure-from-Motion"]
```

Example:
"The session log included measurements (E16) of lens-to-subject distance and ambient humidity."

4. Software Processing Steps

- **E11 Modification**: Software actions altering the model (e.g., "Mesh decimation").
- **E14 Condition Assessment**: Quality checks (e.g., "Model meets LOD3 standard").
- **E39 Actor**: Software or user (e.g., "Agisoft Metashape", "Technician A").
  Visual Mapping:
```
[E11 Modification: "Mesh Decimation"]
├── P33 used specific technique → [E29 Design/Procedure: "Reduce to 500k polygons"]
└── P14 carried out by → [E39 Actor: "Technician A"]
```

Example:
"Decimating the mesh (E11) was logged alongside the technician's rationale (E14: 'Hardware limitations')."

5. Tool and Software Use

- **E24 Physical Man-Made Thing**: Tools (e.g., "Canon EOS R5", "RTI dome").
- **E29 Design or Procedure**: Software workflows (e.g., "Metashape alignment: High accuracy").
  Visual Mapping:

```
[E24 Physical Man-Made Thing: "Agisoft
Metashape v2.0"]
└── P94 has created → [E73 Information
Object: "3D Model"]
```

Example:
"The software (E24) and its alignment settings (E29) were documented to ensure reproducibility."

6. Paradata Reflection Sheet

- **E13 Attribute Assignment**: Interpretive notes (e.g., "Excluded fragment CER-045B due to provenance concerns").
- **E73 Information Object**: The reflection sheet itself (e.g., "Paradata_Log_2023.xml").
- **E65 Creation**: The act of creating the reflection sheet.
  Visual Mapping:

```
[E65 Creation: "Paradata Logging"]
├── P94 has created → [E73 Information
Object: "Paradata_Log_2023.xml"]
└── P141 assigned → [E13 Attribute
Assignment: "Excluded CER-045B"]
```

Example:
"The reflection sheet (E73) recorded ethical decisions (E13) made during model creation (E65)."

Summary: CIDOC-CRM Paradata Workflow Diagram

```
[E7 Activity: Pre-Capture Setup]
├──→ [E9 Move: Image Acquisition]
│     └──→ [E13 Attribute Assignment:
Settings]
├──→ [E16 Measurement: Session Log]
├──→ [E11 Modification: Processing Steps]
│     └──→ [E14 Condition Assessment]
├──→ [E24 Physical Thing: Tools/Software]
└──→ [E65 Creation: Reflection Sheet]
      └──→ [E73 Information Object:Log File]
```

Appendix D: Management of Metadata and Paradata

- **Use Flexible Metadata Standards**
  Adopt **PREMIS** as your metadata schema. It's designed for long-term digital preservation and allows you to document who did what, when, and how. It also works well with changing technologies over time.
- **Automate Documentation with Python**
  Use Python scripts to automatically collect:
  - Camera and sensor settings
  - Software versions and processing steps
  - Time and date stamps during photogrammetry workflows

  This saves time and ensures nothing important is forgotten.
- **Track Changes with Version Control**
  Use tools like **Git** to track changes in your documentation. Every time a model is edited or reprocessed, Python can update the metadata and log it as a new version.
- **Make it Easy for Everyone**
  Build simple forms (online or offline) for staff to record decisions—like why certain edits were made. Python can turn these into PREMIS-compatible logs. No need to know XML or CIDOC-CRM.
- **Link to the Repository**
  Set up Python scripts to send all this metadata and paradata to our digital repository so it stays connected to the 3D models.
- **Schedule Regular Backups**
  Automate regular exports of metadata and logs. These exports show the full history of each model, which helps with audits, reanalysis, or reuse.