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A PAPER FOR THE CUSTODIANS OF HISTORIC PROPERTIES

Laser Scanning for Historic Documentation and Digital Preservation

Commission the record before the next rehabilitation project and before the next loss.

By Brian Hope, Principal · Published by Hope CGI, LLC · Bisbee, Arizona · November 2026
Written for owners, congregations, municipalities, museum boards and historic district commissions.

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What's inside

01 The position

02 What the scanner records

03 What the record is used for

04 The limits of a scan

05 Custody of the data

06 Selecting and working with a LiDAR technician

07 When to scan

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Commission a registered laser scan of the property before the next rehabilitation project and before the next loss. The scan cannot be made afterward.

01 The position

The dimensions of a historic building exist in one place: the building. When fire or structural failure takes the building, the dimensions go with it. What remains is photographs and whatever drawings were made.

A registered laser scan puts those dimensions in a second place. I hold that this record is part of a custodian's duty of care, on the same footing as insurance and a sound roof. It is made without touching the building, and each later project starts from it.

Bisbee has a recent case. On February 14, 2024, fire destroyed two historic buildings on Main Street. The following month the City announced that the burned buildings could not be preserved and would be reconstructed.

Reconstruction to a historic standard runs on evidence. The Secretary of the Interior's Standards for Rehabilitation require that replacement of a missing feature be "substantiated by documentary, physical, or pictorial evidence" (36 CFR 67.7(b)(6)). The reconstruction standard applies only where the documentary and physical evidence is sufficient to rebuild accurately, with little left to conjecture (36 CFR 68.3(d)(1)). After a loss the physical evidence is reduced to what survived. A scan made beforehand is documentary evidence with dimensions.

02 What the scanner records

A terrestrial laser scanner measures the distance and angle to every surface in its line of sight and stores each measurement as a point in three dimensions. One setup is a scan station. Stations are registered to one another through fixed targets, and the result is a single point cloud of the structure in one coordinate system.

Each point carries its position, the strength of the returned signal and, where color is captured, a color value from the scanner's camera. The cloud reads as a measurable photograph of every surface the instrument saw.

Registration governs the accuracy of the whole project. The Park Service states the same: project accuracy depends on how well the scan positions register, and that rests on the operator's planning and experience. I register in FARO SCENE. The registration report states the error between stations.

I use a FARO Focus Premium 70. FARO publishes a 3D accuracy of 2 mm at 10 m and 3.5 mm at 25 m for the Focus Premium series.

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The point cloud records the building as it stands. A wall that is out of plumb is recorded out of plumb, and a floor that has deflected is recorded with its deflection. Conventional drawings straighten those conditions. In a historic structure they are the evidence of how the building was made and how it has moved.

Station count follows the geometry of the structure, and irregular fabric takes more stations than regular rooms. Five Cochise County projects from my own record:

Property	Location	Area (SF)	Scan stations	SF per station
Butterfield Station ruins	Dragoon	1,200	87	14
Tombstone Library	Tombstone	1,287	48	27
Schieffelin Hall	Tombstone	14,540	320	45
Brophy Building	Douglas	29,000	578	50
Tombstone Chamber of Commerce	Tombstone	8,632	81	107

Schieffelin Hall is a two-story adobe hall built in 1881. At San Xavier del Bac Mission the record is a high-resolution point cloud from 400 stations with a photogrammetric mesh.

The point cloud is the source for every later product. From it I produce plans, sections and elevations and a Revit model of the existing structure at LOD 300. Where surface form carries the significance, as with sculpted plaster or carved stone, a mesh records it.

03 What the record is used for

The first use is reconstruction after loss. Notre-Dame de Paris burned on April 15, 2019. Years earlier the art historian Andrew Tallon had scanned the cathedral from more than 50 positions and recorded more than one billion points. Tallon died in 2018. His data was combined with post-fire scans to build the model that guided the reconstruction, and the cathedral reopened in December 2024. The record existed because one person made it before anyone needed it.

Notre-Dame also shows what coverage is worth. The head of the French firm Art Graphique et Patrimoine told AFP that Tallon's model was complete but not exhaustive. His firm held scan data gathered over 25 years, including the spire and the roof that the fire destroyed. A scan that stops at the ceiling leaves the roof framing unrecorded. Scan the attic, the roof structure and the crawl space along with the public rooms.

The second is monitoring. A later scan registered to the same control as the first measures the difference between two dates. Wall lean and roof deflection are then reported as dimensions with a date at each end. Without the first scan there is nothing to measure against.

The third is rehabilitation. The engineer's assessment and the construction documents both start from measured existing conditions, in place of dimensions assumed at the desk. The instrument stands on a tripod and does not touch historic fabric.

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The fourth is review. An application to a historic district commission, or a grant scope, built on a point cloud states existing conditions as measured. The reviewing body decides the application. The scan settles what is there.

The fifth is maintenance. Wall areas, roof areas and opening sizes are measured from the point cloud at the desk, so a plaster, masonry or roofing scope is priced on measured quantities.

The sixth is access. A scan captured with color holds a panoramic view from every station, and the stations are linked into a virtual walkthrough that opens on a screen. The walkthrough serves three groups.

The first is the person who cannot come: kept away by distance, cost, health or a stair with no alternative. Federal rule puts physical access first. The ADA regulation for public entities gives priority to methods that provide physical access to a historic property, and where an alteration is not required it lists audio-visual materials that depict the portions that cannot otherwise be made accessible (28 CFR 35.150(b)(3)). The Park Service's Preservation Brief 32 gives the example of an audio-visual program showing the inaccessible upper floor of a historic house museum. A walkthrough made from the scan is that program, with every room in it measured. Whether it meets a given property's obligation is a determination for the custodian and its counsel.

The second is the educator. A class that cannot travel walks the building on a screen, and a teacher works from the measured drawings and the model. The building takes no wear from the visit.

The third is the visitor on site who meets a closed door. Rooms closed to protect fragile finishes or collections, and spaces closed because a floor, a stair or the structure is not safe for visitors, are scanned once by a technician. The public then sees them without entering.

Access and security pull in opposite directions. The custodian decides, space by space, what is published (Section 6, item 8).

04 The limits of a scan

A scanner records surfaces in its line of sight. It does not see inside a wall, behind plaster or under a floor. It reports geometry and color, and it does not report capacity: whether a leaning wall is stable is a question for an Arizona-registered engineer, who answers it with the measured lean in hand.

The Park Service lists further limits. Scanners record by reflectivity and perform poorly on dark surfaces and on mirror-like ones: glass, water and polished finishes. Vegetation and adjacent features block the line of sight, and the tops and undersides of structures are often out of reach. A scanner does not identify materials and does not distinguish one period of construction from another; the recorder notes those. Long-range scanners leave the edges of complex moldings undefined, so molding profiles are measured by hand or with a close-range instrument.

A heritage scan is therefore paired with field notes, photographs and hand-measured profiles.

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A point cloud is also not the formal record under the federal standard. The National Park Service's Heritage Documentation Programs (HABS, HAER and HALS) use laser scanning on nearly every project and never as the only method. They combine it with hand measurement and produce measured drawings from both. They do not treat scan data as formal documentation, because electronic files do not meet the durability requirement of the Secretary of the Interior's documentation standards, the HABS/HAER Standards. Standard III requires materials that are readily reproducible, durable and in standard sizes.

That position is correct. The scan is the field record. Measured drawings produced from it are the durable record. A custodian needs both.

05 Custody of the data

Digital preservation is a custody obligation with a recurring cost. The Park Service names the risks: catastrophic loss of electronic files, and the continuing cost of transfer and upgrades. Tallon's Notre-Dame data sat on external hard drives at Vassar College, with copies at Columbia University. The second copy at a second institution is the part to imitate.

The Park Service also identifies proprietary software and equipment as the obstacle to long-term preservation of scan data. An open format answers part of that objection. The files still have to be migrated.

Require the following from any scanning provider, in writing, before work starts:

1. The raw scans and the registered point cloud, delivered to you, with ownership stated in the agreement.
2. An export in E57 (ASTM E2807) beside any proprietary format. E57 is an open, vendor-neutral exchange format, and the Library of Congress maintains a format description for it.
3. An accuracy requirement stated in advance under the USIBD Level of Accuracy Specification v3.0, and a registration report stating what was achieved. The specification defines five levels, LOA10 to LOA50, and separates measured accuracy from represented accuracy.
4. Documented control: the fixed targets or survey control used, so a later scan registers to the same coordinates.
5. Measured drawings (plans, elevations and sections) produced from the point cloud and delivered on durable media and as PDF.

Then keep two copies in separate locations, name the person responsible for them, and migrate the files when the storage media or the file formats are retired.

Item 1 includes the records that explain the data: the scan dates, the instrument, the operator, the station count, the control, the registration error and the software versions. The Archaeology Data Service guide, following English Heritage, sets the minimum archive as the raw scans, the registered point cloud and the project, scan and registration metadata. Where a mesh or a set of sections is produced, the guide calls for archiving the interim data set it was made from.

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Item 3 refers to five levels, each stated at the 95 percent confidence level:

Level	Tolerance
LOA10	5 cm to 15 cm
LOA20	15 mm to 5 cm
LOA30	5 mm to 15 mm
LOA40	1 mm to 5 mm
LOA50	0 to 1 mm

The specification allows different elements of one project to carry different levels. State the level for each element before the work starts, and state it separately for the measurement and for the drawings or model made from it.

Where access is a purpose, require a sixth item: a viewing edition of the walkthrough that opens in a web browser without specialist software, with the host, the term and the cost of hosting stated in the agreement. Historic England puts the question to the client directly: whether the client can manage and use what is delivered.

06 Selecting and working with a LiDAR technician

Select the technician on method and stated accuracy, and state the purpose of the survey before asking for a fee. The purpose sets the method.

Start with a written brief. Historic England's guidance on laser scanning for heritage puts these items in the client's brief: the purpose of the survey, the extent of the site, access, safety issues, the end products, the accuracy, the archive and the data rights. Section 5 supplies the last three. The technician answers the brief with a method statement.

Name access in the brief when it is a purpose. It changes the capture: color at every station, stations placed along the route a visitor walks, and coverage of the closed spaces.

Compare proposals on station count, coverage and stated accuracy before fee. Two proposals for the same building with different station counts describe different surveys.

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Ask for	What it establishes
The instrument, its published accuracy and its laser class	Whether the instrument suits the accuracy required. Historic England puts tripod-based scanners at 2 to 5 mm on heritage work at 10 to 50 m, with handheld and backpack units below that. Class 1 is the eye-safe class.
A current calibration certificate	That the instrument measures to its published figures now.
A registration report from a completed project	That registration error is measured and reported.
Sample deliverables from a comparable structure	The level of detail in the point cloud and the measured drawings.
Who performs capture, registration and drawing	Which steps the provider's own staff perform.
The control method	How stations are tied together and who provides survey control.
Certifications and certificates of insurance	Training in the instrument and in accuracy specification (USIBD), and professional and general liability coverage.

One line of scope belongs to another profession. Locating a property line or a boundary corner is land surveying practice under A.R.S. 32-101 and is performed by an Arizona-registered land surveyor. A building scan records the structure and does not establish the boundary.

Once the technician is selected, the custodian's part is as follows:

1. Walk the property together before the scan. Point out the features that carry the significance, the fragile finishes and the rooms that are off limits. Disclose unsafe floors, unstable walls and known asbestos.
2. Hand over what exists: earlier drawings, photographs, reports and any earlier scan with its control.
3. Open everything. Unlock rooms, attic hatches, crawl space and roof access. Move stored contents away from walls, and decide before the visit how vegetation against the building is handled. A surface the scanner cannot see is not recorded.
4. Schedule for an empty building. People and vehicles in a scan are obstructions, and exterior work is timed around sun position.
5. Agree where targets go, and name in advance the surfaces that take no adhesive.
6. Expect field notes with the scan: materials, construction, alterations, instrument settings, date and conditions.
7. Review before acceptance. Read the registration report against the accuracy requirement and go through the point cloud room by room for gaps. The USIBD specification includes a validation section; name the validation method in the agreement.
8. State in the agreement who is permitted to share or publish the data. A point cloud of an interior shows security hardware and collections along with the walls.

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07 When to scan

Scan while the building is intact. Scan again before rehabilitation work starts and after it is complete, so the record shows what was altered. If the building is damaged, scan before debris is removed, because cleanup erases what the standing walls and the debris still record.

A property with no work scheduled still gets a baseline scan. Monitoring depends on a first date, and reconstruction depends on a record made before the loss.

The building will keep changing. The first scan sets the date from which every later change is measured.

Sources

National Park Service, Heritage Documentation Programs: Laser scanning guidance (revised 2023)

National Park Service: HABS/HAER Standards, Standards I to IV

FARO: Focus Premium brochure, performance specifications

USIBD: Level of Accuracy Specification v3.0 release (2019), including the validation specification and LOA history and levels

Library of Congress: E57 format description; ASTM International: E2807

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AFP, April 17, 2019: On American hard drives, the most accurate 3-D model of Notre-Dame

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National Register of Historic Places: Tombstone Historic District nomination (Schieffelin Hall, 1881, two-story adobe)

Code of Federal Regulations: 36 CFR 67.7, Standards for Rehabilitation and 36 CFR 68.3, Standards

KJZZ, February 16, 2024: Fire destroys 2 of Bisbee's historic buildings; KGUN 9: Bisbee building rebuild underway, five weeks after fire

Archaeology Data Service: Guide to good practice, laser scanning: project deliverables and archive

LOA tolerance ranges as reported from the USIBD specification guide (2019): Zagar, Oostwegel and Malovrh Rebec, CHNT 26

Historic England (2018): 3D Laser Scanning for Heritage, sections 2 and 3

Arizona Revised Statutes: A.R.S. 32-101, definitions

Code of Federal Regulations: 28 CFR 35.150, Existing facilities (historic preservation programs)

National Park Service: Preservation Brief 32, Making Historic Properties Accessible

Project areas and station counts: Hope CGI project records.

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About this paper

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Hope CGI, LLC is a building and construction consultancy in Bisbee, Arizona: Construction Documents and LiDAR Imaging. From scan to permit set, one firm. Hope CGI captures, registers and models existing conditions in-house with its own FARO Focus Premium 70, operated by a USIBD- and FARO-certified principal and an in-house trained technician. No part of the scan or drawing production is subcontracted.

Hope CGI, LLC is not an Arizona-registered design professional. Structural assessment is performed by Arizona-registered engineers engaged for the project. This paper is general information, not legal advice or a substitute for a registered design professional, engineer, land surveyor or attorney. Standards, statutes and published figures change over time; the sources are listed with this paper.

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