



Museum Digital Archive

Professional Technology Consulting

The Origami Corporation

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Bringing a Nation’s Treasures Online: A High-Performance Digital Archive for a National Museum

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Bringing a Nation’s Treasures Online: A High-Performance Digital Archive for a National Museum

1.1

Executive Summary

A national museum sought to digitize and open access to its collection of 100,000 artifacts while ensuring long-term preservation. We designed and delivered a modern, searchable online archive with high-resolution imagery, backed by a robust digital asset management (DAM) workflow, a global content delivery network (CDN) for low-latency access, and enterprise-grade colocation for digital preservation servers. The platform now serves 50,000 monthly visitors, increased in-person museum attendance by 25% through online discovery, and safeguards cultural heritage with redundant backup systems and rigorous preservation practices.

1.2

The Challenge

The museum faced a multi-dimensional challenge:

- Scale: Digitizing and publishing 100,000 artifacts with consistent metadata and rights management.
- Performance: Delivering deep-zoom, high-resolution images globally without degrading user experience.
- Preservation: Implementing long-term, tamper-resistant storage with verifiable integrity and disaster recovery.
- Usability: Creating an accessible, intuitive interface for researchers, educators, and the general public.

- **Integration:** Connecting the new archive with existing collections management systems and digitization workflows.
- **Operations:** Providing resilient infrastructure despite limited in-house data center capacity.

Success required uniting web-development, digital-asset-management, cdn-services, ui-ux-design, and colocation under a cohesive architecture that balanced access with preservation.

1.3 Our Approach

We led a phased program from discovery to launch:

- **Discovery and UX research:** Stakeholder interviews, content audits, and audience personas (researchers, educators, casual visitors) informed a content strategy and navigation model. Accessibility targets were set at WCAG 2.1 AA.
- **Information architecture and metadata:** We standardized on a hybrid schema using Dublin Core and CDWA/LIDO elements, and defined controlled vocabularies for artist, period, medium, and geography. Rights and restrictions were encoded at the asset level.
- **Technical architecture:** We implemented a headless DAM with an API-first approach to support multiple front-ends. A search microservice powered by Elasticsearch provided faceted search and relevancy tuning. An IIIF-compatible image server delivered tiled, deep-zoom images. The public website leveraged server-side rendering for SEO and performance.
- **Performance and distribution:** A global CDN with image caching and edge TLS termination ensured sub-2-second page loads for international audiences. HTTP/2, Brotli compression, and cache-control headers were tuned for high edge cache hit ratios.
- **Preservation and colocation:** The museum's digital preservation servers were housed in a Tier III-aligned colocation facility with 2N power, N+1 cooling, and 10 Gbps redundant uplinks. Storage employed erasure coding and ZFS snapshots, with offsite replication for disaster recovery. We defined fixity checks, retention policies, and RPO/RTO objectives aligned to preservation standards.
- **Security and governance:** Role-based access control (RBAC), SSO/MFA for staff, WAF and DDoS protection, and audit logging were integrated end-to-end. We established ingest and review workflows to maintain data quality.

1.4 Implementation

Web development - Front-end: Built with React and server-side rendering to optimize first contentful paint and SEO. A design system ensured consistency across artifact pages, search results, and thematic collections. **- Back-end:**

Node.js/TypeScript services exposed REST and GraphQL APIs for the website and third-party integrations. API gateways enforced rate limits and authentication for partner access. - Search: Elasticsearch powered faceted search across creator, period, medium, location, and rights. Custom analyzers supported multilingual queries and stemming. Relevancy was tuned using clickthrough data post-launch.

UI/UX design - Navigation and discovery: We introduced multiple entry points—curated stories, educator toolkits, and “collections by theme.” Artifact pages included related works and provenance timelines to increase session depth. - Accessibility: Color contrast, keyboard navigation, text alternatives, and structured headings were validated through automated and manual testing. The interface met WCAG 2.1 AA guidelines. - Image interaction: IIIF-based deep-zoom with smooth panning and annotation support enhanced scholarly use while keeping payloads small via tiled delivery.

Digital asset management - Ingest pipeline: A validated ETL process transformed source metadata, applied controlled vocabularies, and generated persistent identifiers. We automated creation of derivatives (thumbnails, web-optimized JPEG/AVIF, and IIIF tiles). - Metadata governance: Editorial review workflows ensured consistency. Rights metadata controlled watermarking and download permissions dynamically via the front-end. - Fixity and integrity: During ingest, SHA-256 checksums were generated and verified on a recurring schedule. Any discrepancies triggered automated quarantine and alerts.

CDN services - Global distribution: We configured a multi-continent edge footprint with origin shield. Cache keys incorporated language and image parameters to maximize hit ratios. - Performance tuning: Brotli compression, HTTP/2, and smart image resizing at the edge reduced bandwidth while preserving fidelity. Typical TTFB dropped to under 200 ms for major regions. - Security: TLS 1.3, HSTS, and a managed WAF rule set mitigated common threats. Bot management reduced scraping and abusive crawling.

Colocation and preservation - Facility: The museum’s preservation servers operate in a carrier-neutral data center with 2N UPS, N+1 generators, and biometric access controls. Redundant 10 Gbps cross-connects provide resilient connectivity to both the museum and CDN origins. - Storage architecture: A combination of object storage (S3-compatible) and ZFS-based file systems provided durability and fast retrieval. Erasure coding across nodes protected against disk and node failures. - Backups and DR: Nightly immutable backups to a secondary region, quarterly tape exports for deep archive, and continuous replication delivered an RPO of 15 minutes and an RTO of under 4 hours for critical systems. - Monitoring: Centralized logging, metrics, and synthetic user monitoring ensured observability. On-call runbooks and incident playbooks supported a 99.97% uptime target.

Integration - Collections management: One-way synchronization from the mu-

seum's collections system ensured authoritative metadata flow, with reconciliation reports to detect gaps or conflicts. - Education and partnerships: Secure API endpoints allowed education partners to embed artifacts in curricula, respecting rights and rate limits.

1.5 Results & Impact

- Audience reach: The platform serves 50,000 monthly visitors, with international users experiencing consistent sub-2-second page loads. Average session duration increased by 38%, driven by faceted discovery and related-works navigation.
- Onsite engagement: Online discovery translated into a 25% increase in physical museum attendance, supported by exhibition tie-ins and "visit this work" CTAs on artifact pages.
- Performance and efficiency: The CDN achieved a 92% edge cache hit ratio, reducing origin bandwidth by 68% and improving TTFB to under 200 ms in key regions. Image optimization lowered average payload sizes by 45% without visible quality loss.
- Data quality and operations: Ingest throughput averaged 1,500 items/day during peak digitization, with automated QA reducing manual corrections by 60%. Editorial workflows cut time-to-publish from weeks to days.
- Reliability and preservation: Uptime measured at 99.97% over the first year. Automated fixity checks detected zero integrity failures across 100,000 preserved master files, while geo-redundant backups and immutable snapshots ensured resilient recovery.
- Accessibility and inclusion: WCAG 2.1 AA compliance expanded usability for diverse audiences, including screen reader users and low-bandwidth visitors, advancing the museum's public mission.

1.6 Technologies & Services Used

- Services: web-development, digital-asset-management, cdn-services, ui-ux-design, colocation
- Web stack: React with server-side rendering, Node.js/TypeScript APIs, GraphQL/REST, API gateway
- Search and data: Elasticsearch, PostgreSQL for metadata, Redis for caching
- Imaging and delivery: IIIF-compatible image server, AVIF/JPEG derivatives, HTTP/2, Brotli compression
- CDN: Global edge caching, origin shield, WAF, DDoS protection, TLS 1.3, HSTS
- DAM and workflows: Headless DAM, ETL for metadata normalization, controlled vocabularies, RBAC

- Preservation infrastructure: S3-compatible object storage, ZFS with snapshots, erasure coding, immutable backups, tape archive
- Colocation: Tier III-aligned facility, 2N power, N+1 cooling, redundant 10 Gbps uplinks, biometric access, remote OOB management
- Monitoring and security: Centralized logging, synthetic monitoring, MFA/SSO, audit logging

1.7 Conclusion

By unifying a user-centered design with a preservation-grade backend, we transformed a static collection into a living, accessible digital archive. The solution balanced speed, scale, and stewardship: high-resolution imagery delivered globally via CDN; rigorous DAM workflows ensuring data integrity; and colocation-backed preservation infrastructure safeguarding assets for future generations. The museum not only expanded its digital footprint with 50,000 monthly visitors but also converted online engagement into a 25% rise in physical attendance. With this foundation, the institution is poised to launch virtual exhibitions, researcher APIs, and educational collaborations—sustaining cultural heritage while meeting modern audience expectations.

About The Origami Corporation

The Origami Corporation is a leading technology consulting firm specializing in cloud migration, DevSecOps, cybersecurity, and digital transformation. We help organizations navigate complex technological challenges and achieve their business objectives through innovative, secure, and scalable solutions.

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